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Aerodynamics Technical Memorandum 407

A USER'S MANUAL FOR THE ARL MATHEMATICAL MODEL OF THE SEA KING MK 50 HELICOPTER: PART II - USE WITH ARL FLIGHT DATA (U)

by

A.M. Arney and N.E. Gilbert

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A. M. ARNEY and N. E. GILBERT

SUMMARY

A mathematical model of the Sea King Mk 50 helicopter, as used in the Anti-Submarine Warfare (ASW) role, has been developed at ARL to run on the Elxsi 6400 computer. To validate this model, extensive flight trials have been conducted by the RAN. This document provides a catalogue of the many flight trials data files, shows how to access and process the flight data, and then how to run the mathematical model with inputs obtained from the flight data.

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1. INTRODUCTION

A mathematical model of the Sea King Mk 50 helicopter, as used in the ASW (Anti-Submarine Warfare) role, has been developed by ARL to a Royal Australian Navy (RAN) task requirement. This model, which was originally developed on a DEC System 10 computer using the simulation language "CSMP-10(ARL)" (Refs 1-3), has been described in general terms in Refs 4 and 5. Full descriptions of the main components, namely the Aerodynamics/ Kinematics, Control Systems, and Cable/Sonar may be found in Refs 6-11. A large data bank derived from an extensive series of Sea King flight trials (Ref. 12) is presently available, the processing of which, together with the application of filtering and kinematic consistency checking procedures, has been described in Refs 13-16. The main purpose of the trials was the acquisition of data for the validation of the mathematical model (Ref. 17).

Assuming a basic knowledge in using the Elxsi 6400 computer, the use of the computer programs associated with the Sea King model is described in three user manuals. Part I (Ref. 18) shows how to set up the model and run it in its basic modes without dunking sonar. The model is first run in ASW mode as a means of trimming the aircraft, i.e. 'flying to trim', and then in either ASW, ASE (Auto Stabilizing Equipment), or pilot modes to simulate a desired manoeuvre. Part II (this one) provides a catalogue of the many flight trials data files (not included in Ref. 12), shows how to access and process the flight data, and then how to run the mathematical model with inputs obtained from the flight data. Part III (Ref. 19) shows how to use the dunking sonar model and demonstrates the use of a cable graphics program.

2. RETRIEVAL OF FLIGHT DATA FROM MAGNETIC TAPE

The unprocessed flight trials data files are available on ARL magnetic tape M135. An example is given below of how to obtain these files, a catalogue of which is given in Appendix A.

To retrieve these files, a request is first made to the operator for tape M135 to be mounted:[1]

```
:MOUNTTAPE M135 -W
:
***From operator at 11:32: Mag tape mounted on tape1
:TAPES
Device Status
device              user            volume    type      density    ring
------              ----            ------    ----      -------    ----
tape1
tape2                               M135      ANSI      6250bpi    No
tape3
No outstanding mount requests for user ae.arney
:
```

[1] For computer terminal input included in this document, messages typed by the user are shown in bold type.

In order to copy one or more of these files from tape M135 to the current directory, shellfile REDATA is available on tape M228 (see Appendix A of Ref. 18). A listing of this file is shown below:

```
:LIST REDATA
- - SHELLFILE TO RESTORE LIST OF FILES FROM MTAPE
parm file +list +req
- - Init shellvariables,'files'=pathname,'count' is a counter
set filelist '' +declare
set count 1 +declare
set filelist  [cat /subdomains/arl/user/ae.williams/seaking/flight_data/  &
       [file [count]]] +append
- - Start of loop to add list of files to pathname
 label loop
set count [eval count+1]
- - If another file is there add to pathname otherwise restore files
 if [file [count]] then
    set filelist     [cat ",/subdomains/arl/user/ae.williams/seaking/flight_data/"  &
              [file [count]]] +append
    goto loop
 else
    goto restore
 end if
- - Restore files
 label restore
 restore [filelist;noquote] vol=M135 merge=flat SEQ=1 -unl +cre
 :
```

Below is an example showing how REDATA is used to restore flight data files 15018 and 15019, assuming the user has mounted tape M135.

```
:REDATA 15018,15019
15018
15019
**********  RESTORE SUMMARY  **********
 2 files restored.
 0 files not restored.
 0 directories restored.
 0 directories not restored.
 All requests were found on tape.
 :
```

3. PROCESSING THE FLIGHT DATA

The raw flight data is processed using the data processing program REFINE, (see Refs 13-16). The program requires the calibration file CAL86 (see Appendix B), which, as well as containing details of the instrument calibrations, also contains labels, plot limits, and characteristics of various filters used. Since REFINE was originally documented in Ref. 13, a digital notch filter has been added (Ref. 16). However, the processing time is

increased dramatically, and it is usually only used for special cases. Both REFINE and CAL86 are available on ARL magnetic tape M228.

For the flight data file 15018, selected here as an example, REFINE is run as follows:

```
:REFINE
INPUT DATA FILENAME = 15018
".DAT" OUTPUT FILENAME (w/o ext) =
TITLE (2 lines of 60 chrs)
:15018 - Hover - Pedal Pulse Port - ASE on - Flt 4
:                1s delay, 5s limit
ARE ASSIGNED BLK NUMBERS REQRD : Y
CALIBRATION FILENAME = CAL86
FLIGHT NUMBER = 4                                          Varies from 1 to 6
DOES CHANNEL 18 MEASURE TORQUE : N                         Ch.18 measures torque or yaw attitude
IS PRE-PROCESSING WITH A NOTCH FILTER REQRD : N            Used in special cases
OUTPUT INTERVAL (in 60'ths of sec; e.g. 12 for 0.2 sec) = 1
STARTING TIME DELAY, NO. BLKS FIRST IGNORED = 1            Found with experience
TIME LIMIT = 5                                             Found with experience
IS FILTERING REQRD : Y
IS OUTPUT OF FILTER CHARACTERISTICS REQRD : N
ARE DIGITAL FILTER DELAY ADJUSTMENTS REQRD : Y
IS SMOOTHING REQRD : N
ARE INSTRUMENT & ANALOGUE FILTER DELAY ADJUSTMENTS REQRD : Y
ARE SCALES AND OFFSETS REQRD : Y
ARE PLOT LIMITS REQRD : Y
ARE DROP-OUTS TO BE CORRECTED : Y
ARE ALL CHANNELS REQRD : N
CHANNEL NUMBERS REQRD FOR FOLLOWING GROUPS
(Set first value -ve if excluding)
(Set first value to -100 if none excluded)
  Instrumentation data   ( 1 to 33) : 1,2,3,4,8,9,11,12,13,14,15,16,17,21, 22, 27, 29, 30
  Boom Calculations      (34 to 40) :
  Blade angles           (41 to 45) : 41,42,43,44,45
  Euler angles           (46 to 47) : 46,47
  Kinematic consistency  (48 to 70) : 54,55,56,57,58,59
DATE = 09-Jan-87
TIME = 14:56:57

IS KINEMATIC CONSISTENCY ITERATION INFORMATION REQRD : N
ARE ANY FAULTY DATA TO BE REPLACED BY ALTERNATIVELY DERIVED DATA: N
No. time corrections =  0
No. blocks replaced =  0
No. drop-out corrections = 265

Fortran program executed STOP statement 1
:
```

The above run creates the files 15018.ERR and 15018.DAT. File 15018.ERR contains a list of errors encountered, including time corrections, blocks replaced, and drop-outs. File 15018.DAT contains the processed data in a format suitable for use as input to the post processing program TRANS (see Sections 4.2 and 5).

It should be noted that suspect angular measurements were recorded in some flights, particularly of yaw angle and yaw rate. These can be detected by comparing with values derived through kinematic consistency checking (Ref. 15).[1] The faulty measurements may then be replaced by the alternatively derived (by integration or differentiation of other measured quantities) values (see Appendix B of Ref. 15).

4. RUNNING THE SEA KING MODEL WITH FLIGHT DATA INPUTS

4.1 Standard Input Files

As described in Section 5.1 of Ref. 18, whenever the model is run, the following three files are required as input:

BOMMP.IN	-	Non-interactive command file for BOMMP
DATA.HEL	-	Helicopter input data, mainly in NAMELIST form
?????.MOD	-	Helicopter model information in form of configuration, parameter, and function statements - must have 5 character name with .MOD extension

Standard helicopter input files and corresponding model files for ASW mode are available at All-Up-Weight (AUW) values of 16600, 17800, and 19200 lb. Where conditions need to be represented more specifically, the input data file (DATA.HEL) can be edited and the model file can be created by re-trimming in ASW mode (see Section 5.2 of Ref. 18).

4.2 Flight Control Inputs

4.2.1 Pedal Inputs

For the file 15018 processed in Section 3, the AUW is given as 16640 lb in Appendix A. Because this is close to the value 16600 lb, the standard files 16600.HEL (renamed to DATA.HEL) and 16ASW.MOD are used. The program SKMODE (see Section 5.3 of Ref. 18) is first run, as shown below, to obtain the ASE mode file 16ASE.MOD:

```
:SKMODE
INPUT FILE (ASW MODE .MOD FILE) : 16ASW
MODEL FILE REQUIRED (ASW,ASE,PIL OR ALL) : ASE
OUTPUT FILE (ASE MODE .MOD FILE) : 16ASE
??ASE.MOD TITLE : SEA KING - Hover - 3000 ft - ASE MODE - 16600lb AUW
:
```

[1] Flight data files which have previously been found to have faulty data are indicated in Appendix A.

The file BOMMP.IN is then edited, replacing 19ASW by 16ASE, to give:

```
:LIST BOMMP.IN
LOG2:16ASE_I
CON
PAR
FUN
MAN
:
```

Finally, a special file containing the flight data control inputs is created using the program TRANS (Refs 2 and 3), which is available on ARL magnetic tape M228. This file is read in by the Sea King model, any deviation from the initial control position being added to the model trim condition. Using the data file 15018.DAT (created in Section 3) as input to TRANS, the file 15018.COL (see Appendix C) is created for use as input to the Sea King model as shown below:

```
:TRANS
[TRANS version date 11-MAR-86]

I/P FILENAME =  15018
15018 - Hover - Pedal Pulse Port - ASE on - Flt 4

I/P FILE RECORDED ON 09-Jan-87 AT 14:56:57

INTEGN INT =  .0000E+00; RUN CPU TIME = 24.98 SEC.

TIME FROM   .0000E+00 TO 5.0000E+00 IN STEPS OF 1.6667E-02

*PRC
PRINTING IN COLUMNS :

BLKS
276,277,72,278,527,292,293,295,294

IS O/P TO TTY REQRD : N
*GOE
** RUNNING **

*EXI
:
```

Having prepared all the relevant files (i.e. BOMMP.IN, 16ASE.MOD, DATA.HEL, and 15018.COL), the model may now be run. Depending on the type of input, a number of switches need to be turned on or off. The example below shows how this is done using the PARameter command, for the case here (see Appendix A), where there is a pedal input with the Automatic Stabilizing Equipment (ASE) on:

```
:SEAKING86
MAX BLK NO. = 500

MAX NO. OF: I & T1 BLKS, U BLKS, F BLKS = 100,25,25

SEA KING - HOVER - 3000 ft - ASE MODE - 16600 lb AUW
*PAR
PARAMETERS :

BLK, P1, P2, P3
57,1                    Read cyclic stick position
74,1                    Read yaw controls
79,1                    Read yaw push-pull-rod position
87,1                    Read collective stick position
90,0                    Do not read blade angles
241,-1                  Do not read blade angles
99,1                    Display monitor output
123,0                   Turn off yaw ASE channel
274,500                 Set yaw ASE channel on in 500 s

*INT
INTEGN PARAMS; LOWER, UPPER, INTERVAL =  0,5,0.02
*OUT
O/P BLKS
276,277,72,278,292,293,295,296
282,283,284,279,280,281,287,288
16,17,18,212,290

O/P PARAMS; % CHANGE REQRD, INTERVAL =  0.0001,0.1
*LOG3:15018_M
MODEL O/P TO    LOG3:15018.MOD

*STO
15018.MOD    NOT ON DSK

CON, PAR, FUN, OR ALL : A
*LOG2:15018_I
MODEL I/P FROM    LOG2:15018.MOD

*LOG1:1518A_O
BLOCK O/P TO    LOG1:1518A.DAT

*GOE
1518A.DAT    NOT ON DSK
** RUNNING **
1518A.HEL    NOT ON DSK
```

```
  (s)     (Ft)   (Ft/m)     (Knots)
 Time     Alt   RoC/D  Speed  Slip  %Torq
    .0  3000.     -.1    -.0  -.00     76.
%Colctv         %Cyclic
              F-A      Lat
 -103.14    -19.82   -1.10
A.S.E. Channels :
PITCH - On
ROLL - On
YAW - Off
ALT HOLD - Off

A.S.W. Mode :
 TRAN
[Cyclic Trim -  RELS]
    .0  3000.     -.1    -.0  -.00     76.
   1.0  3000.      .0    -.0   .02     76.
   2.0  3000.    39.6    -.2   .62     86.
   3.0  3001.    81.7    -.1  1.23     71.
   4.0  3003.   111.6    -.1  1.90     83.
   5.0  3005.   150.1    -.1  2.73     77.
RUN CPU TIME :    15.36 Sec.

*EXI
Fortran program executed STOP statement 0
:
```

The above example creates the output file 1518A.DAT, which can then be used as input to program TRANS, to produce suitable output in tabular or graphical form (see Section 5).

Further explanation of the switches set using the PARameter command is now made. When reading flight control inputs, the cyclic stick and collective stick positions are always read (Blks 57 and 87), as well as a yaw channel input (Blk 74). For pedal inputs, the yaw push-pull-rod movements are read (Blk 79 = 1), whereas for other inputs, the pedal position is read (Blk 79 = 0). This is because the yaw control system is not modelled correctly, and variables required to model the system were not measured (Ref. 17). In the case of a pedal input, a pedal position is derived from the push-pull-rod position, assuming no input from the ASE, and making no allowance for the faulty modelling. For 'ASE on' modelling, the yaw channel should be turned off (Blks 123 and 274), since ASE inputs are already included in the yaw push-pull-rod flight data. The Sea King model also has the facility to read in flight data blade angles (Blks 90 and 241), instead of control positions, thus by-passing the modelling of the flight control system.

4.2.2 Non-Pedal Inputs

Below is an example of how the model is normally run for non-pedal inputs, file 15019 representing a collective input manoeuvre:

```
:SEAKING86
MAX BLK NO. = 500

MAX NO. OF: I & T1 BLKS, U BLKS, F BLKS = 100,25,25

SEA KING - HOVER - 3000 ft - ASE MODE - 16600 lb AUW
*PAR
PARAMETERS :

BLK, P1, P2, P3
57,1                    Read cyclic stick position
74,1                    Read yaw controls
79,0                    Read pedal position
87,1                    Read collective stick position
90,0                    Do not read blade angles
241,-1                  Do not read blade angles
99,1                    Display monitor output
123,1                   Turn on yaw ASE channel
274,0                   Set yaw ASE channel on at time = 0 s

*INT
INTEGN PARAMS; LOWER, UPPER, INTERVAL =  0,5,0.02
*OUT
O/P BLKS
276,277,72,278,292,293,295,296
282,283,284,279,280,281,287,288
16,17,18,212,290

O/P PARAMS; % CHANGE REQRD, INTERVAL =  0.0001,0.1
*LOG3:15019_M
MODEL O/P TO    LOG3:15019.MOD

*STO
15019.MOD    NOT ON DSK

CON, PAR, FUN, OR ALL : A
*LOG2:15019_I
MODEL I/P FROM    LOG2:15019.MOD

*LOG1:1519A_O
BLOCK O/P TO    LOG1:1519A.DAT

*GOE
1519A.DAT    NOT ON DSK
** RUNNING **
```

```
1519A.HEL    NOT ON DSK

  (s)     (Ft)   (Ft/m)     (Knots)
  Time    Alt   RoC/D  Speed  Slip %Torq
    .0  3000.    -.1    -.0  -.00     76.
%Colctv        %Cyclic
             F-A     Lat
 -103.14   -19.82   -1.10
A.S.E. Channels :
PITCH - On
ROLL - On
YAW - On
ALT HOLD - Off

A.S.W. Mode :
 TRAN
[Cyclic Trim -  RELS]
    .0  3000.    -.1   -.0  -.00     76.
   1.0  3000.  146.1    .1   .02     87.
   2.0  3000.  394.2    .4   .25     93.
   3.0  3001.  544.8    .6   .96     89.
   4.0  3003.  653.1    .8  2.22     90.
   5.0  3005.  736.9   1.0  3.58     90.
RUN CPU TIME :    15.14 Sec.

*EXI
Fortran program executed STOP statement 0
:
```

The output data stored as file 1519A.DAT may then be processed using TRANS (see Section 5).

4.3 Engine Cut

During the Sea King flight trials (Ref. 12), a number of tests were done simulating an engine failure, where one engine was closed down to idle, while the other engine automatically increased power. In order to simulate these tests with the Sea King model, a number of changes had to be made to a model file, while leaving the Fortran source files unchanged.

For the file 19092 considered, Appendix A gives the AUW as 19100 lb, the aircraft forward speed as 80 KIAS, and a cut of Engine 2. Being close to the AUW of 19200 lb, the standard files 19200.HEL (renamed to DATA.HEL) and 19ASW.MOD are used.

On inspecting the processed flight data (in which Channel 18 measures torque), it was found that the aircraft was actually at a forward speed of 82 kn in a 4 deg climb. The following steps are required to achieve a trimmed 'ASE mode' model file .

Initially, the 'ASW mode' is used to 'fly to trim' with a forward velocity of 82 kn (138.4 ft/s) in level flight. This is demonstrated in the example below, where set forward

speed (Blk 51) is ramped from 0 to 138.4 over a 200 second interval, and then set constant at 138.4 for a further 200 seconds to stabilize the trim:

```
:SEAKING86          Having first specified 19ASW.MOD as model input file in BOMMP.IN
MAX BLK NO. = 500

MAX NO. OF: I & T1 BLKS, U BLKS, F BLKS = 100,25,25

SEA KING - HOVER - 3000 ft - ASW MODE - 19200 lb AUW
*TIT
TITLE (LIMIT 60 CHRS)
SEA KING - 82 kn, Level Flight - 3000 ft - ASW MODE - 19200 lb AUW
*FUN
FUNCTIONS :

BLK NO. =  51              Set aircraft forward velocity (ft/s)
COORD PAIRS :

0,0
COORD PAIR (   .0000E+00,      .0000E+00) DELETED
200,138.4
400,138.4

BLK NO. =
MODEL COMPLETE

*INT
INTEGN PARAMS; LOWER, UPPER, INTERVAL =  0,400,0.02
*OUT
O/P BLKS
2                  Arbitrary output required for intermediate step

O/P PARAMS; % CHANGE REQRD, INTERVAL =  0.0001,100
*LOG3:TRIM2_M
MODEL O/P TO    LOG3:TRIM2.MOD

*STO
TRIM2.MOD    NOT ON DSK

CON, PAR, FUN, OR ALL : A
*LOG2:TRIM2_I
MODEL I/P FROM    LOG2:TRIM2.MOD

*LOG1:TRIM2_O
BLOCK O/P TO    LOG1:TRIM2.DAT

*GOE
```

```
TRIM2.DAT    NOT ON DSK
** RUNNING **
TRIM2.HEL    NOT ON DSK

  (s)     (Ft)   (Ft/m)     (Knots)
  Time     Alt   RoC/D  Speed  Slip  %Torq
    .0   3000.      .3     .0   .00     90.
%Colctv         %Cyclic
                F-A   Lat
 -94.31     -25.06   -2.49
A.S.E. Channels :
PITCH - On
ROLL - On
YAW - On
ALT HOLD - RAD

A.S.W. Mode :
 TRAN
[Cyclic Trim -  ENGE]
    .0   3000.      .3     .0   .00     90.
   1.0   3000.      .3     .0   .00     90.
   2.0   3000.      .3     .1   .00     90.
   3.0   3000.      .3     .2   .02     90.
   4.0   3000.      .1     .4   .04     90.
   5.0   3000.     -.0     .6   .07     90.
     .
     .
     .
     .
 398.0   3000.      .2   81.9  -.00     45.
 399.0   3000.      .2   81.9  -.00     45.
 400.0   3000.      .2   81.9  -.00     45.
RUN CPU TIME :    7 Min. 38.03 Sec.

*RET
*STO
TRIM2.MOD    NOT ON DSK
CON, PAR, FUN, OR ALL :  A
*EXI
Fortran program executed STOP statement 0
:
```

To now trim the model in a 4 deg climb, the height gain over a 200 second interval is first calculated (= 138.4 x 200 tan 4^{o} = 1935.6 ft/s). The aircraft set height (Blk 80) is then ramped from its starting value of 3000 ft to the final value of 4935.6 ft (= 3000 + 1935.6) over this 200 second interval, while keeping aircraft set speed (Blk 51) constant at 138.4 ft/s:

```
:SEAKING86          Having first specified TRIM2.MOD as model input file in BOMMP.IN
MAX BLK NO. = 500

MAX NO. OF: I & T1 BLKS, U BLKS, F BLKS = 100,25,25

SEA KING - 82 kn, Level Flight - 3000 ft - ASW MODE - 19200 lb AUW
*TIT
TITLE (LIMIT 60 CHRS)
SEA KING - 82 kn, 4deg Climb - 3000 ft - ASW MODE - 19200 lb AUW
*FUN
FUNCTIONS :

BLK NO. = 51                Set aircraft forward velocity (ft/s)
COORD PAIRS :

0,138.4
COORD PAIR (   .0000E+00,      .0000E+00) DELETED

BLK NO. = 80                Set aircraft height(ft)
COORD PAIRS :

200,4935.6

BLK NO. =
MODEL COMPLETE

*INT
INTEGN PARAMS; LOWER, UPPER, INTERVAL =  0,200,0.02
*OUT
O/P BLKS
2                   Arbitrary output required for intermediate step

O/P PARAMS; % CHANGE REQRD, INTERVAL =  0.0001,100
*LOG3:4DCLM_M
MODEL O/P TO    LOG3:4DCLM.MOD

*STO
4DCLM.MOD    NOT ON DSK

CON, PAR, FUN, OR ALL : A
*LOG2:4DCLM_I
MODEL I/P FROM    LOG2:4DCLM.MOD

*LOG1:4DCLM_O
BLOCK O/P TO    LOG1:4DCLM.DAT
```

```
*GOE
4DCIM.DAT    NOT ON DSK
** RUNNING **
4DCIM.HEL    NOT ON DSK

  (s)     (Ft)   (Ft/m)     (Knots)
  Time     Alt   RoC/D   Speed  Slip %Torq
    .0  3000.      .2   81.9  -.00     45.
%Colctv         %Cyclic
              F-A     Lat
 -116.65    -4.10    -3.95
A.S.E. Channels :
PITCH - On
ROLL - On
YAW - On
ALT HOLD - RAD

A.S.W. Mode :
 TRAN
[Cyclic Trim -  ENGE]
    .0  3000.      .2   81.9  -.00     45.
   1.0  3001.   192.8   82.0   .51     53.
   2.0  3006.   394.4   82.2  -.73     61.
   3.0  3014.   492.8   82.1  -.90     57.
   4.0  3022.   515.5   82.0  -.40     57.
   5.0  3031.   499.8   81.8  -.02     54.
     .
     .
     .
     .
 198.0  4872.   580.8   81.9   .00     60.
 199.0  4881.   580.9   81.9   .00     60.
 200.0  4891.   580.8   81.9  -.00     60.
RUN CPU TIME :    3 Min. 53.37 Sec.

*RET
*STO
4DCIM.MOD    NOT ON DSK
CON, PAR, FUN, OR ALL :  A
*EXI
Fortran program executed STOP statement 0
:
```

The model file 4DCLM.MOD obtained above is then used as input to program SKMODE in order to obtain the ASE model file 4DASE as follows:

```
:SKMODE
 INPUT FILE (ASW MODE .MOD FILE) : 4DCLM
 MODEL FILE REQUIRED (ASW,ASE,PIL OR ALL) : ASE
 OUTPUT FILE (ASE MODE .MOD FILE) : 4DASE
 ??ASE.MOD TITLE : SEA KING - 82kn,4deg Climb - ASE MODE - 19200lb
:
```

This model file can then be used as input, as shown below, to obtain the results shown in Appendix D:

```
:SEAKING86          Having first specified 4DASE.MOD as model input file in BOMMP.IN
MAX BLK NO. = 500

MAX NO. OF: I & T1 BLKS, U BLKS, F BLKS = 100,25,25

SEA KING - 82kn, 4deg Climb - ASE MODE - 19200lb
*TIT
TITLE (LIMIT 60 CHRS)
SEA KING - 82 kn, 4deg Climb - Engine Cut, ASE MODE - 19200 lb
*CON
CONFIGURATIONS :
BLK, TYPE, B1, B2, B3
316,+,-183,326; TRQ DIF        See Appendix E for detailed explanation
324,F,1;    QENG2
325,T1,324;QENG2 DEL
326,+,315,325; TRQENG
327,G,315; TORQ1
328,G,325; TORQ2
329,K; DUMMY

*PAR
PARAMETERS :

BLK, P1, P2, P3
14,-3000
83,3000,4.6
149,-3000
302,125
313,385.16,.45
314,18720,.45877
325,18719,.3
327,3.18E-3
328,3.18E-3

*FUN
FUNCTIONS :
```

```
BLK NO. =  324                    Set Engine 2 torque (ft-lb)
COORD PAIRS :

0,18719
1.7,18719
1.71,0
500,0

BLK NO. =
MODEL COMPLETE

*INT
INTEGN PARAMS; LOWER, UPPER, INTERVAL =  0,10,0.02
*OUT
O/P BLKS
A
O/P PARAMS; % CHANGE REQRD, INTERVAL =  0.0001,0.1
*LOG3:ENGCT_M
MODEL O/P TO    LOG3:ENGCT.MOD

*STO
ENGCT.MOD    NOT ON DSK

CON, PAR, FUN, OR ALL : A
*LOG2:ENGCT_I
MODEL I/P FROM    LOG2:ENGCT.MOD

*LOG1:1992A_O
BLOCK O/P TO    LOG1:1992A.DAT

*GOE
1992A.DAT    NOT ON DSK
** RUNNING **
1992A.HEL    NOT ON DSK

  (s)     (Ft)   (Ft/m)     (Knots)
 Time     Alt   RoC/D  Speed  Slip %Torq
    .0  3000.   580.8   81.9  -.00     30.
%Colctv        %Cyclic
             F-A     Lat
-107.94    6.80    -3.06
A.S.E. Channels :
PITCH - On
ROLL - On
YAW - On
ALT HOLD - Off
```

```
A.S.W. Mode :
 TRAN
[Cyclic Trim -  ENGE]
    .0   3000.   580.8   81.9   -.00      30.
   1.0   3010.   580.9   81.9    .00      30.
   2.0   3019.   577.1   81.9    .28      30.
   3.0   3028.   497.0   81.8   2.11      53.
   4.0   3036.   465.6   81.7   -.53      61.
   5.0   3044.   460.3   81.7   -.92      54.
   6.0   3052.   446.9   81.6   -.39      55.
   7.0   3059.   439.0   81.6   -.45      56.
   8.0   3066.   436.1   81.6   -.45      55.
   9.0   3073.   433.5   81.6   -.37      55.
  10.0   3081.   431.9   81.6   -.35      55.
RUN CPU TIME :    22.11 Sec.

*EXI
Fortran program executed STOP statement 0
:
```

5. COMPARING FLIGHT DATA WITH SEA KING MODEL RESULTS

As well as being able to obtain output, in tabular or graphical form, of either the flight data or Sea King model results separately, the program TRANS (Refs 1-3) may also be used to overlay plots from both for comparison purposes. An example is now given on comparing processed flight data (15018.DAT) obtained in Section 3 with corresponding model data (1518A.DAT) obtained in Section 4.2.1.

Though TRANS allows plot limits to be set automatically, this is inadvisable when obtaining overlay plots, as the scales are determined by the initial data file and may not be appropriate for subsequent data files plotted as overlays. It is recommended therefore that the plot limits be set using the SCAle command, either creating the limits interactively or reading them in from existing scale files TRANS.SCA and REPT.SCA. The file TRANS.SCA is used by the first data file, and the file REPT.SCA, which should be a copy of TRANS.SCA, is used by subsequent data files to be plotted as overlays. For the case here, the file HOVER.SCA, which is on ARL magnetic tape M228, should be renamed TRANS.SCA and then copied as REPT.SCA.

To avoid the tedious retyping of block numbers that are commonly required to be output in groups, it is advisable to use a TRANS.BLK file, which contains lists of each group of blocks to be output together (usually eight variables in 'strip' plot form to a page). For the present case, the standard TRANS.BLK file (on tape M228), which was originally generated using the LISt command (a TRANS command rather than the Elxsi operating command), is used.

Given the files HOVER.SCA (renamed to TRANS.SCA and REPT.SCA) and TRANS.BLK, which are listed in Appendix F, TRANS can now be run as follows:

```
:TRANS
[TRANS version date 11-MAR-86]

I/P FILENAME =  15018
15018 - Hover - Pedal Pulse Port - ASE on - Flt 4

I/P FILE RECORDED ON 09-Jan-87 AT 14:56:57

INTEGN INT =  .0000E+00; RUN CPU TIME = 24.98 SEC.

TIME FROM   .0000E+00 TO 5.0000E+00 IN STEPS OF 1.6667E-02

*SPA
IS SPACING BETWEEN PLOTS REQRD : N
*SCA
BLK NO. -1 DENOTES INDEP VARIABLE

ARE PLOT SCALE LIMITS TO BE READ FROM DSK : Y
IS TTY LISTING OF LIMITS REQRD : N
ARE MODIFICATIONS REQRD : N
*PLS
IS GRAPHICS OUTPUT TO SCREEN REQUIRED : N[1]
[PLS/O Output, for this run, going to DSK:15018.PLT          ]

STRIP PLOTS :

BLKS
L1,L2,L3

TO SPECIFY NO. OF X UNITS/INCH, TYPE 0 FOR X

LENGTH OF AXES IN INCHES; X, Y = 0,1
MIN X, NO. OF X UNITS/INCH = 0,1
ARE SYMBOLS REQRD FOR PLOTS : N
LINE KEY (0 GIVES DEFAULT) = 0
*GOE
** RUNNING **

*REP

I/P FILENAME = 1518A
ARE SYMBOLS REQRD FOR PLOTS : N
```

1 It should be noted that when using the REPeat command, the user should specify that no graphics output to the screen is required.

```
LINE KEY (0 GIVES DEFAULT) = 0
** RUNNING **

I/P FILENAME =
Fortran program executed STOP statement 1
:
```

The above run creates the metafiles 15018.PLT, 15018.PL0, and 15018.PL1 (since three pictures are requested representing the groups L1, L2, and L3). The output of these files obtained on the Zeta8 plotter using the shellfile 'Plot', is shown in Appendix G. This shellfile, which is on ARL magnetic tape M228 and is listed below, is designed so that Zeta8 plots of TRANS files are in inches.

```
.LIST PLOT
-- SHELLFILE TO PLOT FILES CREATED BY 'TRANS' ON ZETA8
-- FRAME SIZE ENSURES MAXIMUM USE OF PAPER WIDTH
-- FILENAME AND PICTURE NUMBER MAY EITHER BE INCLUDED
-- ON COMMAND LINE OR WILL BE PROMPTED FOR
parm file
parm no
label get_file
-- If filename has been specified go to label get_picture_no
-- otherwise prompt for filename
if [file] then
else
declare file
echo 'Filename : ' -n
-- '-n' stops cursor on same line as echo
-- search line for 1 string and place it in file
set file [find ?* occurrence=1]
end if
-- if file exists go to label get_picture_no, otherwise prompt
-- for another filename
if [FileExists [file]] then
else
echo 'Filename '[file]' does not exist'
forget file
goto get_file
end if
label get_picture_no
-- if picture number is specified, plot file, otherwise prompt
-- for picture number
if [no] then
else
declare no
echo 'Picture number : ' -n
set no [find ?* occurrence=1]
```

```
end if
-- if no is not a number, then prompt for picture number
if [echo [no] | find %0<9*$] then
else
echo 'Invalid picture number '[no]
forget no
goto get_picture_no
end if
plot.zt8 [file] picno=[no] frame=534,267
printers
:
```

Plot operates as shown below. Note that Plot will prompt for the filename and/or picture number, if they are not included in the command line.

```
:Plot 15018.PLT 1

   jobID     state      user         title         size     pri     time     destination
   ------    -------    ----------   -----------   ----     ---     ----     -----------
     89      active     ae.arney     15018.PLT      436     norm    15:22    cc.zeta8
```

6. CONCLUDING REMARKS

Perhaps the most significant achievement in developing the Sea King model has been the extent to which it has been validated against flight data. The capabilities of the model, as well as limitations, are consequently reasonably well understood. However, this and any further validation requires a knowledge of how to process the ARL flight data, as well as how to run the model using these data as inputs in order to ensure compatibility between theoretical and experimental results. To keep alive this capability, especially following transfer of the model and flight data from the obsolete DEC System 10 to the Elxsi 6400, it has been necessary therefore to fully document all aspects of the model in the form of these *user manuals*. Inclusion here of a comprehensive catalogue of the computer records of the flight data has been considered necessary in view of current expectations on the value of the flight data in future studies, both in the application of parameter identification techniques to helicopter modelling and in the validation of a Sea King analysis, rather than simulation, model being developed using the CAMRAD (Comprehensive Analytical Model of Rotorcraft Aerodynamics and Dynamics) code.

REFERENCES

1. Gilbert, N.E. and Nankivell, P.G., "The Simulation Language CSMP-10(ARL)," *ARL Aero Note 362*, May 1976.

2. Gilbert, N.E. and Nankivell, P.G., "Further Information for Users of the Simulation Language CSMP-10(ARL)," *ARL Aero Note 375*, May 1978.

3. Nankivell, P.G. and Gilbert, N.E., "A General Purpose Output Program for Use in Simulation," *ARL Aero Note 367*, December 1976.

4. Guy, C.R., Williams, M.J., and Gilbert, N.E., "Sea King Anti-Submarine Warfare Helicopter Mathematical Model," *Mech. Engg. Trans., I.E. Aust.*, Vol. ME7, pp. 23-29, April 1982.

5. Guy, C.R., Williams, M.J., and Gilbert, N.E., "A Mathematical Model of the Sea King Mk 50 Helicopter in the ASW Role," *ARL Aero Report 156*, June 1981.

6. Williams, M.J. and Arney, A.M. "A Mathematical Model of the Sea King Mk 50 Helicopter Aerodynamics and Kinematics," *ARL Aero Tech Memo 379*, June 1986.

7. Guy, C.R. "Sea King Mk 50 Helicopter/Sonar Dynamics Study: A Simplified Control Systems Mathematical Model," *ARL Aero Report 152*, February 1979.

8. Guy, C.R. "Sea King Mk 50 Flight Control System: A Mathematical Model of the Flying Controls," *ARL Aero Note 388*, February 1979.

9. Guy, C.R. "Sea King Mk 50 Flight Control System: A Mathematical Model of the AFCS (Autostabilizer/Autopilot Model)," *ARL Aero Note 389*, February 1979.

10. Guy, C.R. "Sea King Mk 50 Flight Control System: A Mathematical Model of the AFCS (ASW Mode)," *ARL Aero Note 393*, June 1979.

11. Gilbert, N.E. "A Mathematical Model of the Dynamics of the Cable and Sonar Transducer for a Sea King Mk 50 Helicopter," (to be published).

12. Guy, C.R. and Williams, M.J. "Sea King Helicopter Flight Trials," *ARL Aero Note 415*, January 1983.

13. Gilbert, N.E. "Data Reduction Procedures for Sea King Helicopter Flight Trials," *ARL Aero Tech Memo 338*, May 1982.

14. Gilbert, N.E. and Fleming, J.A. "Digital Filtering of Helicopter Flight Data," *ARL Aero Note 406*, January 1982.

15. Gilbert, N.E. and Williams, M.J. "Preliminary Kinematic Consistency Checking of Helicopter Flight Data," *ARL Aero Note 414*, January 1983.

16. Perrin, R.H. and Feik, R.A. "Application of a Digital Notch Filter to Elimination of Sinusoidal Disturbances from Helicopter Flight Data," *ARL Aero Tech Memo 382*, April 1986.

17. Williams, M.J. and Arney, A.M. "Validation of the ARL Mathematical Model of the Sea King Mk 50 Helicopter," *ARL Aero Tech Memo 383*, November 1986.

18. Arney, A.M. and Gilbert, N.E., "A User's Manual for the ARL Mathematical Model of the Sea King Mk 50 Helicopter: Part I - Basic Use," *ARL Aero Tech Memo 406*, October 1988.

19. Gilbert, N.E. and Arney, A.M. "A User's Manual for the ARL Mathematical Model of the Sea King Mk 50 Helicopter : Part III - Use of Dunking Sonar Model," *ARL Aero Tech Memo* (to be published).

20. "Operating Data Manual - Sea King Mk 50," *A.P. (RAN) 300-8-2*.

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APPENDIX A
Flight Data Catalogue

File	Approx. length (s)	Flight number	Estimated A.U.W. (lb)	Comments
11002	1.4	3	19800	Compass heading checks - 270 deg
11003	1.4	3	"	180 deg
11004	1.4	3	19750	090 deg
11005	1.4	3	"	Doppler checks, Low speed trim, AFCS on 20 km/hr
11006	1.4	3	"	40 km/hr
11007	2.1	3	"	60 km/hr
11008	1.4	3	"	80 km/hr
11009	1.4	3	"	-15 km/hr
11010	1.4	3	"	-30 km/hr
11011	1.4	3	"	15 km/hr Port
11012	1.4	3	"	30 km/hr Port
11013	2.1	3	"	15 km/hr Stbd
11014	2.1	3	"	30 km/hr Stbd
11015	2.1	3	"	Doppler checks, Low speed trim, AFCS off 15 km/hr Port
11016	2.1	3	"	30 km/hr Port
11017	2.8	3	"	15 km/hr Stbd
11018	2.1	3	"	30 km/hr Stbd
11019	2.1	3	"	20 km/hr Fwd
11020	2.1	3	"	40 km/hr Fwd
11021	1.4	3	"	60 km/hr Fwd
11022	1.4	3	"	80 km/hr Fwd
11023	2.1	3	"	Hover
11024	3.5	3	"	* Ignore - see repeat (11026) -15 km/hr
11025	1.4	3	"	-30 km/hr
11026	1.4	3	"	-15 km/hr
11027	2.1	3	19050	Doppler, Level flight, High speed trim, AFCS off 60 kn
11028	1.4	3	"	70 kn
11029	2.1	3	"	80 kn
11030	1.4	3	"	90 kn
11031	2.1	3	"	100 kn
11032	1.4	3	"	AFCS on 110 kn
11033	7.7	3	18925	AFCS off, Hover, Collective step up (1)
11034	8.4	3	"	(2)

File	Approx. length (s)	Flight number	Estimated A.U.W. (lb)	Comments
11035	2.1	3		step down (1)
11036	7.0	3		step up (2) repeat sample
11037	9.1	3		* Ignore
11038	4.9	3		AFCS off, Hover, Collective step up (2) repeat sample
11039	10.5	3		step down (1) repeat sample
11040	22.4	3		* Ignore - poor manoeuvre
11041	16.8	3		step down (2)
11042	7.7	3		step up (1)
11043	7.7	3		step up (2)
11044	15.4	3		step down (1)
11045	14.0	3		step down (2)
11046	2.1	3		pulse down (1)
11047	2.1	3		pulse up
11048	3.5	3		pulse down (2)
11049	5.6	3		doublet
11050	8.4	3	18200	AFCS off, 80 kn, Collective Step Up (1)
11051	8.4	3		Step Up (2)
11052	7.7	3		Step Down (1)
11053	8.4	3		Step Down (2)
11054	4.2	3		Pulse Up (1)
11055	4.9	3		Pulse Down (1)
11056	5.6	3		Pulse Up (2)
11057	3.5	3		Pulse Down (2)
11058	9.1	3		Doublet
11059	3.5	3		* Ignore - see 11060
11060	6.3	3	18110	Doublet
11062	8.4	4	17300	AFCS on, 80 kn, Collective Step Down
11063	6.3	4		Pulse Up (1)
11064	8.4	4		Pulse Up (2)
11065	9.8	4		AFCS on, 80 kn, Pedal Step Left (1)
11066	18.9	4		Step Left (2)
11067	9.8	4		Pulse Stbd (1)

File	Approx. length (s)	Flight number	Estimated A.U.W. (lb)	Comments
				Pulse Stbd (2)
11068	6.3	4	16900	AFCS off, Hover, Pedal Step Stbd (1)
11069	10.5	4	16780	Step Left (1)
11070	12.6	4	"	Step Stbd (2)
11071	7.0	4	"	Step Left (2)
11072	9.8	4	"	Pulse Stbd
11073	11.9	4	"	AFCS off, Hover, Pedal Pulse Left
11074	11.9	4	"	Doublet
11075	9.1	4	"	AFCS on, Hover, Pedal Step Port
11076	8.4	4	"	Step Stbd
11077	10.5	4	"	Pulse Port
11078	8.4	4	16640	AFCS on, Hover, Collective Step Up
11079	16.8	4	16590	Step Down
11080	10.5	4	"	Doublet Down/Up
11081	10.5	4	16500	AFCS off, 80 kn, Pedal Step Stbd (1)
11082	7.0	3	16950	(2)
11083	11.9	3	"	Step Port (1)
11084	7.7	3	"	(2)
11085	12.6	3	"	Pulse Port (1)
11086	4.9	3	"	(2)
11087	8.4	3	"	Pulse Stbd (1)
11088	10.5	3	"	(2)
11089	30.8	3	"	Doublet Stbd/Port
11090	9.1	3	"	Doublet Port/Stbd
11091	10.5	3	16800	
				AFCS off, 80 kn, Cyclic step aft (1)
12001	5.6	3	17250	(2)
12002	4.9	3	"	fwd (1)
12003	3.5	3	"	(*Initial Step Missed) fwd (2)
12004	4.9	3	"	fwd (2)
12005	5.6	3	"	pulse fwd (1)
12006	16.8	3	"	fwd (2)
12007	15.4	3	"	aft (1)
12008	14.7	3	17200	

File	Approx. length (s)	Flight number	Estimated A.U.W. (lb)	Comments
12009	14.7	3		aft (2)
12010	10.5	3		doublet (1)
12011	12.6	3		(2)
12012	7.0	3		AFCS off, 80 kn, Cyclic step port (1)
12013	9.1	3		port (2)
12014	5.6	3		stbd (1)
12015	6.3	3		stbd (2)
12016	12.6	3		pulse port (1)
12017	12.6	3		pulse port (2)
12018	10.5	3		AFCS off, 80 kn, Cyclic pulse stbd (1)
12019	11.9	3		pulse stbd (2)
12020	22.4	3		doublet (1)
12021	7.7	3		doublet (1)
12022	13.3	3		doublet (2)
12023	9.8	3	16950	doublet (2)
12024	7.0	4	17490	AFCS on, 80 kn, Cyclic step aft (1)
12025	11.9	4		aft (2)
12026	11.9	4		fwd
12027	14.0	4		pulse aft (1)
12028	7.7	4		pulse aft (1)
12029	7.0	4		step port (1)
12030	7.7	4		step port (2)
12031	7.7	4		pulse stbd (1)
12032	8.4	4		pulse stbd (2)
12033	6.3	4	17300	pulse stbd (2)
13001	2.1	5	19200	Towed Probe Tests, Trial run, 40 KIAS
13002	2.8	5		50 KIAS
13003	2.1	5		Extra Sample 50 KIAS
13004	2.8	5		60 KIAS
13005	2.1	5		Extra Sample 60 KIAS
13006	21.0	5		Towed Probe Tests, Coordinated Turn, 60 KIAS

File	Approx. length (s)	Flight number	Estimated A.U.W. (lb)	Comments
13007	2.1	5	19150	15 deg roll in turn
13008	2.1	5	"	69 KIAS
13009	2.1	5	"	35 KIAS
13010	2.1	5	"	79-81 KIAS
13011	2.1	5	"	90 KIAS
13012	2.1	5	"	101 KIAS
13013	2.8	5	"	Extra Sample 101 KIAS
13014	2.1	5	"	110 KIAS
13015	2.1	5	"	Extra Sample 110 KIAS
13016	3.5	5	"	Towed Probe Banked Turns, AFCS on - Level Flt Datum, 40 kn
13017	4.9	5	18780	10 deg Left Bank
13018	7.7	5	"	20 deg Left Bank
13019	16.8	5	"	* Ignore
13020	6.3	5	"	Towed Probe Banked Turns, AFCS on - 10 deg Right Bank
13021	2.1	5	"	* Ignore
13022	2.1	5	"	Level Flt Datum, 40 kn
13023	2.8	5	"	10 deg Right Bank
13024	3.5	5	"	20 deg Right Bank
13025	2.1	5	"	Towed Probe Banked Turns, AFCS off - Level Flt Datum, 40 kn
13026	2.1	5	"	10 deg Left Bank
13027	2.8	5	"	20 deg Left Bank
13028	3.5	5	"	10 deg Right Bank
13029	3.5	5	"	20 deg Right Bank
13030	2.1	5	"	Towed Probe Banked Turns, AFCS off - Level Flt Datum, 80 kn
13031	2.8	5	"	10 deg Left Bank
13032	2.8	5	"	20 deg Left Bank
13033	2.8	5	"	10 deg Right Bank
13034	2.8	5	"	20 deg Right Bank
13035	2.8	5	"	Towed Probe Banked Turns, AFCS on - Level Flt Datum, 80 kn
13036	2.8	5	18530	10 deg Left Bank
13037	2.8	5	"	20 deg Left Bank
13038	2.8	5	"	10 deg Right Bank
13039	2.1	5	"	20 deg Right Bank

File	Approx. length (s)	Flight number	Estimated A.U.W. (lb)	Comments
13040	2.1	5		Level Flt Datum
13041	2.1	5		Extra Sample
13042	2.8	5		Towed Probe Level Flight Trim, AFCS on, 60 kn
13043	2.8	5		82 kn
13044	5.6	5		100-103 kn
13045	1.4	6	19820	Compass Check - 15 deg
13046	1.4	6		15 deg (repeat)
13047	2 1	6		Hover Performance, Rotor Speed vs Torque - Height=40 ft, Nr=103%
13048	2.1	6		94%
13049	2.1	6		96%
13050	2.1	6	19400	98%
13051	2.1	6		100%
13052	2.1	6		102%
13053	1.4	6		104%
13054	2.1	6		106%
13055	2.1	6		Hover Performance, Rotor Speed vs Torque - Height=185 ft, Nr=106%
13056	2.1	6		Extra Sample
13057	2.1	6		Height=175 ft, Nr=104%
13058	2.8	6		Height=165 ft, Nr=100%
13059	2.1	6		Height=160 ft, Nr=98%
13060	2.1	6		Height=155 ft, Nr=96%
13061	2.1	6		Height=155 ft, Nr=94%
13062	2.8	6	19050	Vertical Climb/Descent, Climb (2)
13063	2.1	6		(1)
13064	2.1	6		(2) Extra Sample
13065	2.1	6		Descent 200 fpm
13066	2.1	6		Climb/Descent Performance - Climb 47 KIAS
13067	2.8	6		Extra Sample
13068	2.1	6		Descent 40 KIAS? (45)
13069	2.1	6		Extra Sample
13070	2.1	6		Climb 60 KIAS
13071	2.1	6		Descent 60 KIAS

File	Approx. length (s)	Flight number	Estimated A.U.W. (lb)	Comments
13072	2.1	6	|	Extra Sample
13073	2.1	6	|	Climb 80 KIAS
13074	2.1	6	|	Extra Sample
13075	2.1	6	|	Descent 80 KIAS
13076	2.1	6	|	Extra Sample
13077	2.1	6	|	Climb 100 KIAS (95)
13078	2.1	6	|	Extra Sample
13079	1.4	6	|	Descent 100 KIAS
13080	1.4	6	18800	Extra Sample
13081	1.4	6	|	Autorotation Conditions, 80 KIAS
13082	2.1	6	|	60 KIAS
13083	2.1	6	18600	40 KIAS
13084	2.1	6	18220	Hover Performance, Height vs Torque (medium AUW) - Height= 5 ft
13085	2.1	6	|	10 ft
13086	2.1	6	|	20 ft
13087	1.4	6	|	40 ft
13088	2.1	6	|	60 ft
13089	2.1	6	|	80 ft
13090	2.1	6	|	Hover Performance, Height vs Torque(medium AUW) - Height= 100 ft
13091	1.4	6	|	200 ft
13092	2.1	6	|	300 ft
13093	1.4	6	|	400 ft
13094	1.4	6	|	500 ft
13095	3.5	6	|	Spot Turns - To Port (fast)
13096	2.1	6	|	(slow)
13097	3.5	6	|	To Stbd (slow)
13098	2.1	6	18015	(fast)
13099	3.5	7	19650	AFCS on, Level Flt Datum, 80 KIAS, Height=1000 ft
13100	18.9	7	19600	Steady Heading S/Slips, AFCS on, 80 kn - S/Slips to right
13101	14.7	7	|	AFCS on, 80 KIAS, S/Slips to Left - 2 levels
13102	24.5	7	|	50 KIAS, Right
13103	14.7	7	|	Left
13104	4.2	7	|	Climbs and Autorotations - 50 KIAS, Climb, 100% torque

File	Approx. length (s)	Flight number	Estimated A.U.W. (lb)	Comments
13105	5.6	7		40 KIAS, Autorotation
13106	4.2	7		60 KIAS, Climb, 100% torque
13107	2.8	7		60 KIAS, Autorotation
13108	4.9	7		80 KIAS, Climb, 100% torque
13109	3.5	7		80 KIAS, Autorotation
13110	3.5	7		Banked Turns - 60 KIAS, Level Flt Datum
13111	2.1	7		10 deg Bank to Port
13112	2.1	7		20 deg Bank to Port
13113	3.5	7		30 deg Bank to Port (1300 ft)
13114	2.1	7		10 deg Bank to Stbd
13115	1.4	7		20 deg Bank to Stbd
13116	2.1	7		30 deg Bank to Stbd (1150 ft)
13117	.7	7		Level Flt Datum
13118	4.9	7		Zero Speed Autorotation - Test 1 (see 22003)
13119	2.1	7		Extra Sample
13120	1.4	7	19190	* Poor sample — Test 2
14001	6.3	3	17250	AFCS off, 80 kn, Cyclic Step Fwd
14002	13.3	3	17200	Pulse Aft
14003	16.8	3	17000	Pulse Port
14004	2.8	4	18070	AFCS off, Hover, Cyclic Step 1" Aft
14005	4.2	4	18070	AFCS off, Hover, Cyclic Step 0.5" Aft
14006	1.4	4		0.5" Fwd (*too short)
14007	7.0	4		Repeat Sample OK
14008	4.9	4		AFCS off, Hover, Cyclic Step 1" Fwd
14009	7.7	4		Pulse 1" Fwd (1)
14010	7.0	4		(2)
14011	9.8	4		Pulse 1" Aft (1)
14012	8.4	4		(2)
14013	9.1	4		Doublet 1" Fwd (1)
14014	7.0	4		(2)
14015	4.9	4		Step 1" Port (1)

File	Approx. length (s)	Flight number	Estimated A.U.W. (lb)	Comments
14016	4.9	4		(2)
14017	6.3	4		Step 1" Stbd (1)
14018	7.0	4		(2)
14019	7.7	4		Doublet Port
14020	7.7	4	17660	Stbd
14021	10.5	4	16660	AFCS on, Hover, Cyclic Step 1" Fwd
14022	9.1	4		Aft
14023	8.4	4		Left
14024	7.7	4	16550	Right
14025	178.0	3	17570	Transition Down then Up
14026	91.1	4	19460	Transition Down - Wind 5 kn
14027	44.2	4		Beeping - AFCS on, Hover, Beep 2 s Fwd & Recovery
14028	38.5	4		Aft
14029	32.9	4		Port
14030	30.1	4		Stbd
14031	44.2	4	19320	Cable Disturbance - Cable Fwd in Funnel (see 21082 for Aft case)
15001	8.4	4	17300	AFCS on, 80 kn, Collective Step 1" Down (1)
15002	7.7	4		(2)
15003	6.3	4		Pulse 1" Up (1)
15004	6.3	4		(2)
15005	9.8	4		AFCS on, 80 kn, Pedal Step 1" Left (1)
15006	18.2	4		(2)
15007	7.7	4		Pulse 1" Stbd (1)
15008	6.3	4	16900	(2)
15009	6.3	4	16780	AFCS off, Hover, Pedal Step 1" Stbd (1)
15010	9.1	4		Left (1)
15011	6.3	4		Stbd (2)
15012	10.5	4		Left (2)
15013	8.4	4		Pedal Pulse Stbd
15014	8.4	4		Left
15015	8.4	4		Doublet (repeat manoeuvre)
15016	7.0	4		AFCS on, Hover, Pedal Step Port

File	Approx. length (s)	Flight number	Estimated A.U.W. (lb)	Comments
15017	9.8	4	"	Stbd
15018	8.4	4	16640	Pulse Port
15019	8.4	4	16590	AFCS on, Hover, Collective Step 1" Up
15020	6.3	4	"	Down
15021	7.7	4	16500	Pulse Down/Up
15022	7.0	3	16950	AFCS off, 80 kn, Pedal Step Stbd (1)
15023	7.7	3	"	(2)
15024	11.2	3	"	Port (1)
15025	9.1	3	"	(2)
15026	6.3	3	"	Pulse Port (1)
15027	6.3	3	"	(2)
15028	8.4	3	"	Stbd (1)
15029	9.8	3	"	(2)
15030	9.1	3	"	Doublet (1)
15031	8.4	3	16800	(2) (opposite)
15032	96.7	3	18000	Transition Down
15033	86.2	3	17570	Transition Down
15034	78.5	3	"	Transition Up
15035	54.7	3	17360	Transition Down (*limited time)
16001	1.4	3	19550	Doppler Check & Trim - AFCS on, 20 km/hr Fwd (1)
16002	1.4	3	"	(2)
16003	2.1	3	"	(3)
16004	1.4	3	"	40 km/hr Fwd (1)
16005	1.4	3	"	(2)
16006	1.4	3	"	(3)
16007	1.4	3	"	60 km/hr Fwd (1)
16008	.7	3	"	(2)
16009	21.0	3	"	Doppler Check & Trim - AFCS on, 60 km/hr Fwd (3)
16010	.7	3	"	80 km/hr Fwd (1)
16011	1.4	3	"	(2)
16013	.7	3	"	15 km/hr Aft (1)

File	Approx. length (s)	Flight number	Estimated A.U.W. (lb)	Comments
16014	1.4	3		(2)
16015	.7	3		30 km/hr Aft (1)
16016	.7	3		(2)
16017	.7	3		(3)
16018	1.4	3		Hover (1)
16019	.7	3		(2)
16020	.7	3	19300	(3)
16022	.7	3		Doppler Check & Trim - AFCS off, 20 km/hr Fwd (1)
16023	.7	3		(2)
16024	.7	3		40 km/hr Fwd (1)
16025	.7	3		(2)
16026	1.4	3		(3)
16027	.7	3		60 km/hr Fwd
16028	.7	3		80 km/hr Fwd
16029	1.4	3		Hover (1)
16030	.7	3		(2)
16031	1.4	3		(3)
16032	1.4	3		15 km/hr Aft (1)
16033	1.4	3		(2)
16034	1.4	3		(3)
16035	2.8	3		30 km/hr Aft (1)
16036	1.4	3		(2)
16037	.7	3		40 km/hr Fwd
16038	.7	3		60 km/hr Fwd
16039	.7	3		80 km/hr Fwd (1)
16040	.7	3		(2)
16041	1.4	3	19050	30 km/hr Aft
16042	.7	3		Doppler Check & Trim (high speed) - AFCS off, 60 kn (1)
16043	1.4	3		(2)
16044	1.4	3		(3)
16045	.7	3		70 kn (1)
16046	1.4	3		Doppler Check & Trim (high speed) - AFCS off, 70 kn (2)
16047	1.4	3		(3)

File	Approx. length (s)	Flight number	Estimated A.U.W. (lb)	Comments
16048	1.4	3	|	80 kn (1)
16049	1.4	3	|	(2)
16050	1.4	3	|	(3)
16051	1.4	3	|	90 kn (1)
16052	1.4	3	|	(2)
16053	1.4	3	|	100 kn (1)
16054	1.4	3	|	(2)
16055	2.1	3	|	(3)
16056	1.4	3	|	Doppler Check & Trim (high speed) - AFCS on, 110 kn (1)
16057	1.4	3	|	(2)
16058	1.4	3	|	(3)
16059	1.4	3	18925	(4)
17001	.7	4	16900	* Ignore
17002	4.2	4	|	AFCS off, 40 kn, Cyclic Step 1" Aft
17003	9.8	4	|	Doublet Aft
17004	2.1	4	|	* Ignore - see 17005
17005	8.4	4	|	AFCS on, 40 kn, Cyclic Step 1" Aft
17006	9.8	4	|	Fwd
17007	14.0	4	|	Port
17008	12.6	4	|	Stbd
17009	10.5	4	|	AFCS off, 40 kn, Cyclic Step 1" Port
17010	9.1	4	|	Stbd
17011	10.5	4	|	Doublet Left
17012	9.8	4	|	Stbd
17013	13.3	4	|	AFCS off, 40 kn, Collective Step Up (1) *poor pulse
17014	11.2	4	|	repeat (2)
17015	11.2	4	|	* Ignore - see 17016
17016	11.9	4	|	AFCS off, 40 kn, Collective Pulse Down (2)
17017	10.5	4	|	AFCS on, 40 kn, Collective Step up *(Torque2)
17018	11.2	4	|	Pulse Down (1) * Abort
17019	8.4	4	|	(2) * repeat OK (Torque2)

File	Approx. length (s)	Flight number	Estimated A.U.W. (lb)	Comments
17020	11.2	4		* Abort (repeat manoeuvre,Torque2)
17021	9.1	4		* OK repeat (Torque2)
17022	9.8	4		AFCS off, 40 kn, Pedal Step 1" Stbd
17023	15.4	4		Port
17024	14.0	4		Pulse 1" Stbd
17025	16.1	4		AFCS on, 40 kn, Pedal Step 1" Stbd
17026	13.3	4		Port
17027	11.2	4	16780	Pulse 1" Stbd
17028	90.4	4	19230	Transition Up
17029	96.7	4	19460	Transition Down (1)
17030	99.5	4	19400	Transition Down (2)
17031	95.3	3	18000	Transition Down
17032	63.8	3	17250	Transition Up (30 kn wind)
18001	176.6	3	17570	Transition Down/Up (only initial 50 s valid)
18002	90.4	3		Transition Down
18003	86.2	3	17400	Transition Up
18004	68.7	3	17250	Transition Up (repeat manoeuvre)
18005	67.3	3	17250	Transition Up (repeat sample)
18006	32.9	3	18000	Doppler Hover Disturbances & Recovery - Fwd
18007	30.1	3		Aft
18008	18.2	3		Port
18009	31.5	3		Stbd
18010	34.3	3		Aft (repeat sample)
18011	23.8	3		Height Disturbances (Rad. Alt. Hold) - Up & Down
18012	10.5	3		Up
18013	12.6	3	17920	Down
18014	28.0	4	19800	Beeping - 40 KIAS, Fwd beep & recovery *(see also 19033)*
18015	16.8	4		Aft (see also 19034)
18016	1.4	4		35 KIAS, Port beep & recovery (*Ignore - see 18017)
18017	14.7	4	19600	repeat OK
19002	1.4	1	AUW	Compass Check: - 240 deg
19003	1.4	1	not	270 deg

File	Approx. length (s)	Flight number	Estimated A.U.W. (lb)	Comments
19004	1.4	1	measured	300 deg
19005	.7	1	"	330 deg
19006	2.1	1	"	000 deg
19007	1.4	1	"	030 deg
19008	1.4	1	"	060 deg
19009	1.4	1	AUW	Compass Checks - 090 deg
19010	1.4	1	not	120 deg
19011	1.4	1	measured	150 deg
19012	1.4	1	"	180 deg
19013	1.4	1	"	* Ignore
19014	1.4	2	"	Compass Checks - 270 deg
19015	1.4	2	"	000 deg
19016	1.4	2	AUW	090 deg
19017	1.4	2	not	180 deg
19018	2.8	2	measured	* Ignore
19019	1.4	3	19800	Compass Checks - 000 deg (North)
19020	1.4	3	"	270 deg
19021	1.4	3	"	180 deg
19022	1.4	3	19750	090 deg
19023	1.4	4	17000	Compass Checks - 220 deg (landing)
19024	1.4	5	19300	Compass Checks - 090 deg
19025	1.4	5	19250	180 deg
19026	1.4	5	17900	310 deg
19027	.7	5	"	270 deg
19028	.7	5	"	180 deg
19029	1.4	5	"	090 deg
19030	.7	5	17700	000 deg
19031	14.7	6	19820	Compass Checks - 015 deg
19032	1.4	7	19150	210 deg
19033	26.6	4	19800	Beeper Inputs - 40 KIAS, Fwd Beep & Recovery (18014 is better)
19034	9.1	4	"	Aft (18015 is better)
19035	14.7	4	"	35 KIAS Port (18017 is better)

File	Approx. length (s)	Flight number	Estimated A.U.W. (lb)	Comments
19036	18.2	4	19600	40 KIAS Stbd
19037	2.8	1	AUW	Towed Probe (S/Slips) - 60 KIAS, 10% Torque Descent
19038	2.1	1	not	Left S/Slip
19039	4.2	1	measured	70 KIAS, 10% Torque Right S/Slip
19040	4.9	1	"	Left S/Slip
19041	4.2	1	"	45 KIAS, 65% Torque
19043	1.4	2	"	Level Flight Trim - 52 KIAS (1)
19044	1.4	2	"	(2)
19045	1.4	2	"	Level Flight Trim - 61 KIAS (1)
19046	1.4	2	"	(2)
19047	1.4	2	"	(3)
19048	1.4	2	"	70 KIAS (1)
19049	1.4	2	"	(2)
19050	1.4	2	"	(3)
19051	1.4	2	"	Level Flight Trim - 87 KIAS (1)
19052	1.4	2	"	(2)
19053	1.4	2	"	(3)
19054	1.4	2	AUW	95 KIAS (1)
19055	1.4	2	not	(2)
19056	1.4	2	measured	(3)
19058	1.4	3	19300	AFCS on, 15 km/hr Port (1)
19059	2.1	3	"	(2)
19060	.7	3	"	30 km/hr Port (1)
19061	.7	3	"	(2)
19062	.7	3	"	(3)
19063	.7	3	"	15 km/hr Stbd (1)
19064	.7	3	"	(1)
19065	1.4	3	"	(3)
19066	.7	3	"	30 km/hr Stbd (1)
19067	.7	3	"	(2)
19068	1.4	3	"	(3)
19069	.7	3	"	AFCS off, 15 km/hr Port (1)
19070	.7	3	"	(2)

File	Approx. length (s)	Flight number	Estimated A.U.W. (lb)	Comments
19071	.7	3	|	(3)
19072	1.4	3	|	30 km/hr Port (1)
19073	1.4	3	|	(2)
19074	1.4	3	|	(3)
19075	1.4	3	|	15 km/hr Stbd (1)
19076	1.4	3	|	(2)
19077	1.4	3	|	(3)
19078	1.4	3	|	30 km/hr Stbd (1)
19079	1.4	3	|	(2)
19080	1.4	3	19150	(3)
19082	11.2	4	19600	Engine Cuts - 80 KIAS, No2 Engine Cut (1)
19083	11.2	4	|	(2) (Torque2 not recorded)
19084	17.5	4	|	40 KIAS, No1 Engine Cut
19085	14.7	4	|	No2
19087	25.9	4	19260	Cable Hover, Disturbance And Recovery - Cable Port in Funnel
19088	41.4	4	|	Ball Raised from 100 ft
19090	14.0	4	|	Engine Cuts - 40 KIAS, No2 Engine Cut
19091	16.1	4	|	80 KIAS, No1 Engine Cut
19092	21.0	4	19100	No2
19093	17.5	6	18650	Manoeuvring Stability - AFCS off, 80 KIAS (1)
19094	16.1	6	|	(2)
19095	18.2	6	|	(3)
19096	16.8	6	|	(4)
19097	27.3	6	|	40 KIAS
19098	9.1	6	|	60 KIAS (1)
19099	21.7	6	|	(2)
19100	18.9	6	18400	(3)
19101	70.1	3	17770	Cable Hover, Disturbance & Recovery - Cable Fwd in Funnel
19102	41.4	3	|	Aft
19103	47.7	3	|	Port
19104	30.8	3	17570	Stbd

File	Approx. length (s)	Flight number	Estimated A.U.W. (lb)	Comments
21001	1.4	2	AUW	Yaw Rate Tests - 180 deg to Stbd in 56 s (1)
21002	1.4	2	not	(2)
21003	1.4	2	measured	(3)
21004	1.4	2		32 s (1)
21005	1.4	2		(2)
21006	2.1	2		16 s (1)
21007	1.4	2		(2)
21008	1.4	2		180 deg to Port in 66 s (1)
21009	1.4	2		(2)
21010	1.4	2		(3)
21011	1.4	2		(4)
21012	1.4	2		36 s (1)
21013	1.4	2		(2)
21014	2.1	2		15 s (1)
21015	1.4	2		Yaw Rate Tests - 180 deg to Port in 15 s (2)
21016	4.9	2		Rotor Speed Test - Autorotative Pullout, Nr=114~115%
21017	7.0	2		* Ignore
21018	115.6	2		Typical Landing Phase
21019	2.1	2		Temperature Calibration - Altitude 1000 ft
21020	2.1	2		2000 ft
21021	1.4	2		Doppler Checks - 40 KIAS (1)
21022	2.1	2		(2)
21023	2.1	2		60 KIAS (1)
21024	2.1	2		(2)
21025	2.1	2		80 KIAS (1)
21026	1.4	2		(2)
21027	2.1	2		100 KIAS (1)
21028	2.1	2		(2)
21029	2.1	2		100 KIAS, Primary Hydraulics 'off'
21030	3.5	2		65 KIAS, Primary Hydraulics 'off'
21031	2.1	2		100 KIAS, Aux. Hydraulics off
21032	2.1	2		70/80 KIAS Maximum R/Climb
21033	11.9	2		70 KIAS Autorotation (1)

File	Approx. length (s)	Flight number	Estimated A.U.W. (lb)	Comments
21034	2.1	2		(2) (continuing)
21035	2.1	2		100 KIAS, Nr=95%
21036	2.1	2		100 KIAS, Nr=100%
21037	2.8	2		100 KIAS, Nr=105%
21038	1.4	2		20 KIAS, Nr=104%
21039	62.4	2		Approach and Landing Phase
21041	2.1	2		Rad. Alt. Calibration - Rad. Alt. Smooth = 20 ft
21042	2.1	2		Rad. Alt. Raw = 40 ft
21043	2.1	2		Rad. Alt. Smooth = 40 ft
21044	1.4	2		Rad. Alt. Raw = 60 ft
21046	.7	2		Rad. Alt. Smooth = 80 ft
21047	1.4	2		Rad. Alt. Raw = 100 ft
21048	2.1	2		Rad. Alt. Raw = 200 ft
21049	1.4	2		Rad. Alt. Smooth = 200 ft
21050	1.4	2		Rad. Alt. Raw = 300 ft
21051	2.1	2		Rad. Alt. Calibration - Rad. Alt. Smooth = 300 ft
21052	1.4	2		Rad. Alt. Calibration - Rad. Alt. Raw = 400 ft
21053	1.4	2		Rad. Alt. Smooth = 400 ft
21054	1.4	2		Rad. Alt. Raw = 500 ft
21055	2.1	2		Rad. Alt. Smooth = 500 ft
21056	1.4	2		Pitch Attitude Gyro Checks - 10 deg Nose Up (1)
21057	1.4	2		20 deg (1) (unstable)
21058	2.1	2		0 deg
21059	1.4	2		0 deg
21060	1.4	2		10 deg Nose Up (2)
21061	1.4	2		20 deg (2) (unstable)
21062	1.4	2		10 deg Nose Down
21063	1.4	2	AUW	20 deg Nose Up
21064	1.4	2	not	20 deg Nose Down
21065	1.4	2	measured	30 deg Nose Up
21066	40.6	3	17920	Raising and Lowering Ball - Ball Lowered to 50 ft depth
21067	21.0	3		Ball Lowered to 100 ft depth from 50 ft

File	Approx. length (s)	Flight number	Estimated A.U.W. (lb)	Comments
21068	30.1	3	"	Ball Lowered to 200 ft depth from 100 ft
21069	33.6	3	17770	Ball Raised to 100 ft depth from 200 ft
21070	1.4	3	-----	* Ignore
21071	50.5	3	17570	Ball Raised to Helo. and Transition Up
21072	2.1	3	17360	S/Slip Vane Tests - Heading into wind
21073	2.1	3	"	240 deg
21074	1.4	3	"	245 deg
21075	1.4	3	"	250 deg
21076	1.4	3	"	255 deg
21077	1.4	3	"	260 deg
21078	1.4	3	"	265 deg
21079	1.4	3	17250	275 deg
21080	1.4	3	19600	280 deg
21081	13.3	4	19600	80 KIAS, No1 Engine Cut (Torque2 not recorded)
21082	38.5	4	19320	Cable Disturbance and Recovery - Cable Aft in Funnel
21083	16.8	4	19200	40 KIAS, No1 Engine Cut
21084	74.3	4	16500	Landing Phase (end of Flt 4)
21085	86.9	6	19500	Vertical Climb 40 ft to 200 ft
22001	1.4	3	16775	* Ignore
22002	96.0	3	16775	Landing Phase (end of Flt 3)
22003	65.2	7	19210	Complete Zero Knot Autorotation and Flare Out
22004	106.5	7	19150	Landing Phase (end of Flt 7)
22005	2.1	5	18390	S/Slips (Vane inoperative) - AFCS on, 40 KIAS, Level Flt Datum
22006	2.1	5	"	5 deg Left S/Slip
22007	2.1	5	"	10 deg Left S/Slip
22008	2.1	5	"	5 deg Right S/Slip
22009	2.1	5	"	10 deg Right S/Slip
22010	1.4	5	"	AFCS off, 40 KIAS, Level Flt Datum (1)
22011	2.1	5	"	(2)
22012	1.4	5	"	5 deg Left S/Slip
22013	2.1	5	"	10 deg Left S/Slip
22014	1.4	5	"	5 deg Right S/Slip

File	Approx. length (s)	Flight number	Estimated A.U.W. (lb)	Comments
22015	1.4	5	|	5 deg Right S/Slip
22016	1.4	5	|	10 deg Right S/Slip (Steady increase)
22017	1.4	5	|	* Ignore
22018	1.4	5	18200	AFCS off, 80 KIAS, Level Flt Datum (1)
22019	1.4	5	|	(2)
22020	1.4	5	|	(at lower altitude)
22021	2.1	5	|	5 deg Left S/Slip
22022	1.4	5	|	10 deg Left S/Slip
22023	1.4	5	|	10 deg Right S/Slip (1)
22024	1.4	5	|	(2)
22025	1.4	5	|	5 deg Right S/slip
22026	2.1	5	18050	AFCS on, 80 KIAS, Level Flt Datum
22027	8.4	5	|	Left S/Slip (smoothly varied to 10 deg)
22028	2.1	5	|	Left S/Slip (smoothly varied to 10 deg)
22029	3.5	5	|	Right S/Slip (smoothly varied to 15 deg)
22030	2.1	5	|	Right S/Slip (smoothly varied to 15 deg)
22031	1.4	5	18000	Right S/Slip (smoothly varied to 15 deg)
23001	35.0	7	19650	Steady Level Flight, 80 KIAS
23002	33.6	7	|	Climbs & Autorotations - 50 KIAS Climb, 100% Torque
23003	25.9	7	|	40 KIAS Autorotation
23004	30.8	7	|	60 KIAS Climb, 100% Torque
23005	4.9	7	|	60 KIAS Climb, 100% Torque (Short record after 23004)
23006	26.6	7	|	Climbs & Autorotations - 60 KIAS Autorotation
23007	29.4	7	|	80 KIAS Climb, 100% Torque
23008	20.3	7	|	80 KIAS Autorotation
23009	144.4	7	19210	Banked Turns - 10,20,30 deg banks to Port/Stbd at 60 KIAS
23010	117.0	6	18050	Spot Turns - Fast/Slow Port/Stbd
23011	21.7	6	19050	Latter part of vertical climb
23012	28.0	6	|	Vertical Descent (prev. 13065)
23013	28.7	6	|	Climbs & Descents - 47 KIAS Climb
23014	8.4	6	|	47 KIAS Climb (additional sample - same climb)

File	Approx. length (s)	Flight number	Estimated A.U.W. (lb)	Comments
23015	32.2	6	"	* Doubtful use - part level flight/dive
23016	17.5	6	"	45 KIAS Descent
23017	30.8	6	"	60 KIAS Climb
23018	29.4	6	"	60 KIAS Descent
23019	28.7	6	"	80 KIAS Climb
23020	23.8	6	"	80 KIAS Descent
23021	23.1	6	"	100 KIAS Climb
23022	18.2	6	18800	100 KIAS Descent
24001	7.0	6	19820	* Ignore - initial part of take-off sequence
24002	72.2	6	"	Take-off Sequence
24003	39.9	6	19700	Hover at 40 ft, Nr=103%
24004	40.6	2	AUW	Yaw Rate Calibration - 180 deg Stbd in 56 s
24005	20.3	2	not	32 s
24006	16.8	2	measured	16 s
24007	44.2	2	"	180 deg Port in 66 s
24008	34.3	2	AUW	36 s
24009	21.7	2	not	15 s
24010	23.8	2	measured	Autorotation and Pullout (High Nr=114%)
24011	122.6	5	17900	Steady Level Flight (Returning to Nowra NAS from Jervis Bay)
24012	115.6	5	"	Steady Level Flight (Returning to Nowra NAS from Jervis Bay)
24013	124.8	5	17700	Steady Level Flight (Returning to Nowra NAS from Jervis Bay)
25001	117.7	2	AUW not measured	Level Flight - 5 Speeds with fixed collective stick (60% torque)
25002	5.6	3	19550	Low Speed Doppler, Level Flt - AFCS on, 20 km/hr
25003	11.2	3	"	40 km/hr
25004	7.7	3	"	60 km/hr
25005	24.5	3	"	80 km/hr
25006	5.6	3	"	Low Speed Doppler, Level Flt - AFCS on, -15 km/hr
25007	9.1	3	"	-30 km/hr
25008	8.4	3	19300	15 km/hr Port
25009	6.3	3	"	30 km/hr Port
25010	7.0	3	"	15 km/hr Stbd
25011	7.0	3	"	30 km/hr Stbd

File	Approx. length (s)	Flight number	Estimated A.U.W. (lb)	Comments
25012	5.6	3		AFCS off, 15 km/hr Port
25013	4.9	3		30 km/hr Port
25014	6.3	3		15 km/hr Stbd
25015	7.0	3		30 km/hr Stbd
25016	4.2	3		20 km/hr
25017	7.7	3		40 km/hr
25018	10.5	3		60-80 km/hr
25019	5.6	3		-15 km/hr
25020	7.7	3	19050	-30 km/hr
25021	10.5	3		High Speed Doppler, Level Flt - AFCS off, 60 kn
25022	9.8	3		70 kn
25023	11.2	3		80 kn
25024	9.1	3		90 kn
25025	10.5	3		100 kn
25026	13.3	3	18925	AFCS on, 110 kn
25027	18.2	5	19200	Level Flt Towed Probe Tests - AFCS on, 40 KIAS
25028	14.0	5		35 KIAS
25029	11.2	5		35 KIAS (additional sample)
25030	21.0	5		50 KIAS
25031	21.7	5		60 KIAS
25032	18.2	5	19150	69 KIAS
25033	9.8	5		79-81 KIAS
25034	6.3	5		79-81 KIAS (additional sample)
25035	18.9	5		90 KIAS
25036	25.2	5		101 KIAS
25037	29.4	5	18780	110 KIAS

TITLE (2 lines of 60 chrs)
FLIGHT 5 WITH EXCEPTIONS FOR OTHER FLIGHTS AT END. CH 18 MAY
BE SET (IN REFINE) TO TORQUE(2) USING CAL CONSTS FOR CH 29
[Channel no. -1 denotes time]

Channel No.	Label	Cal Factor, Offset	Assigned No.	Plot Limits (Lower,Upper)	Filter Characteristics (Freq, Atten) (No. Poles)		Smoothing Characteristics (No. Pts Smoothed) (No. Params)	Notch Filter Characteristics (Alpha, dF) (Min Freq., Max Freq., Exp Freq.)		
-1	Time	1.6667E-02								
	(s)	.0000E+00								
1	PITCH STK	1.0690E-02	276	-1.0000E+01						
	(DEG)	-2.2100E+01		1.0000E+01						
2	ROLL STK	1.0690E-02	277	-1.0000E+01						
	(DEG)	-2.4600E+01		1.0000E+01						
3	COLL STK	-5.4900E-03	278	.0000E+00						
	(DEG)	2.0700E+01		2.0000E+01						
4	PITCH VANE	-4.4700E-02	285	-2.0000E+01	3.5000E+00	5.0000E+01		9.5000E-01	1.0000E-01	
	(DEG)	8.7300E+01		2.0000E+01		5		3.0000E+00	6.0000E+00	3.5000E+00
5	F-A PPR	-4.3330E-05	505	-5.0000E-02						
	(FT)	9.8300E-02		5.0000E-02						
6	LAT PPR	4.9000E-05	506	-5.0000E-02						
	(FT)	-1.2750E-01		5.0000E-02						
7	COLL PPR	6.3080E-05	507	.0000E+00						
	(FT)	-3.5800E-02		2.0000E-01						
8	PITCH RATE	-1.5000E-02	279	-1.0000E+01	3.5000E+00	5.0000E+01	17	9.5000E-01	1.0000E-01	
	(DEG/S)	3.2700E+01		1.0000E+01		5	3	3.0000E+00	6.0000E+00	3.5000E+00
9	SSLIP VANE	-4.4700E-02	286	-2.0000E+01	3.5000E+00	5.0000E+01		9.5000E-01	1.0000E-01	
	(DEG)	8.7300E+01		2.0000E+01		5		3.0000E+00	6.0000E+00	3.5000E+00
10	ROLL ATT	2.0750E-02	510	-2.0000E+01	3.5000E+00	5.0000E+01	17	9.5000E-01	1.0000E-01	
	(DEG)	-4.2300E+01		2.0000E+01		5	3	3.0000E+00	6.0000E+00	3.5000E+00
11	ROLL RATE	-3.0300E-02	280	-2.0000E+01	3.5000E+00	5.0000E+01	17	9.5000E-01	1.0000E-01	
	(DEG/S)	6.1440E+01		2.0000E+01		5	3	3.0000E+00	6.0000E+00	3.5000E+00
12	LONG ACC	-1.5880E-01	18	-1.0000E+01	3.5000E+00	5.0000E+01		9.5000E-01	1.0000E-01	
	(FT/S**2)	3.2570E+02		1.0000E+01		5		3.0000E+00	6.0000E+00	3.5000E+00
13	LAT ACC	-1.5710E-01	17	-1.0000E+01	3.5000E+00	5.0000E+01		9.5000E-01	1.0000E-01	
	(FT/S**2)	3.2180E+02		1.0000E+01		5		3.0000E+00	6.0000E+00	3.5000E+00
14	VERT ACC	1.5710E-01	16	-4.0000E+01	4.0000E+00	3.0000E+00		9.9000E-01	5.0000E-02	
	(FT/S**2)	-3.2185E+02		-2.0000E+01		5		3.0000E+00	6.0000E+00	3.5000E+00
15	PITCH ATT	-2.1000E-02	282	-2.0000E+01	3.5000E+00	5.0000E+01	17	9.5000E-01	1.0000E-01	
	(DEG)	4.4600E+01		2.0000E+01		5	3	3.0000E+00	6.0000E+00	3.5000E+00
16	YAW PEDAL	1.8190E-04	72	-1.0000E-01						
	(FT)	-3.8800E-01		1.0000E-01						

17	YAW RATE	1.6400E-02	281	-1.0000E+01	4.0000E+00	3.0000E+00	17	9.9000E-01	5.0000E-02
	(DEG/S)	-3.3090E+01		1.0000E+01		5	3	3.0000E+00	6.0000E+00 3.5000E+00
18	YAW ATT	8.8400E-02	518	-2.0000E+02	3.5000E+00	5.0000E+01	17	9.5000E-01	1.0000E-01
	(DEG)	-6.9000E+01		2.0000E+02		5	3	3.0000E+00	6.0000E+00 3.5000E+00
19	LAT C ANG	-1.3940E-02	165	-1.0000E+01	3.5000E+00	5.0000E+01		9.5000E-01	1.0000E-01
	(DEG)	3.6700E+01		1.0000E+01		5		3.0000E+00	6.0000E+00 3.5000E+00
20	LONG C ANG	5.5400E-03	164	-1.0000E+01	3.5000E+00	5.0000E+01		9.5000E-01	1.0000E-01
	(DEG)	-1.1100E+01		1.0000E+01		5		3.0000E+00	6.0000E+00 3.5000E+00
21	LONG DOPP	-6.6400E-02	287	.0000E+00	3.5000E+00	5.0000E+01		9.5000E-01	1.0000E-01
	(KN)	1.3600E+02		1.0000E+02		5		3.0000E+00	6.0000E+00 3.5000E+00
22	LAT DOPP	-3.6400E-02	288	-2.0000E+01	3.5000E+00	5.0000E+01		9.5000E-01	1.0000E-01
	(KN)	7.4000E+01		2.0000E+01		5		3.0000E+00	6.0000E+00 3.5000E+00
23	DYN PRESS	-9.5500E-05	523	.0000E+00	3.5000E+00	5.0000E+01		9.5000E-01	1.0000E-01
	(PSI)	3.6600E-01		4.0000E-01		5		3.0000E+00	6.0000E+00 3.5000E+00
24	RAD ALT RW	-2.6600E-01	289	.0000E+00	3.5000E+00	5.0000E+01		9.5000E-01	1.0000E-01
	(FT)	5.5300E+02		4.0000E+02		5		3.0000E+00	6.0000E+00 3.5000E+00
25	RAD ALT SM	-1.6300E-01	525	.0000E+00	3.5000E+00	5.0000E+01		9.5000E-01	1.0000E-01
	(FT)	3.3500E+02		4.0000E+02		5		3.0000E+00	6.0000E+00 3.5000E+00
26	ABS PRESS	-9.2500E-04	526	1.3000E+01	3.5000E+00	5.0000E+01		9.5000E-01	1.0000E-01
	(PSI)	1.5800E+01		1.5000E+01		5		3.0000E+00	6.0000E+00 3.5000E+00
27	YAW PPR	4.9000E-05	527	-5.0000E-02					
	(FT)	-1.1250E-01		5.0000E-02					
28	AMB TEMP	1.2200E-02	528	1.0000E+01	3.5000E+00	5.0000E+01		9.5000E-01	1.0000E-01
	(DEG C)	-1.1000E+01		3.0000E+01		5		3.0000E+00	6.0000E+00 3.5000E+00
29	TORQUE(1)	-3.9300E-02	212	4.0000E+01	4.0000E+00	3.0000E+00		9.9000E-01	5.0000E-02
	(PERCENT)	1.4110E+02		8.0000E+01		5		3.0000E+00	6.0000E+00 3.5000E+00
30	ROTOR RPM	1.1450E-02	290	1.0200E+02	4.0000E+00	2.0000E+01		9.9000E-01	5.0000E-02
	(PERCENT)	8.5200E+01		1.0600E+02		5		3.0000E+00	6.0000E+00 3.5000E+00
31	TOWED DYN	-1.3890E-04	531	.0000E+00	3.5000E+00	5.0000E+01		9.5000E-01	1.0000E-01
	(PSI)	5.1000E-01		4.0000E-01		5		3.0000E+00	6.0000E+00 3.5000E+00
32	TOWED DIFF	-4.8800E-05	532	.0000E+00	3.5000E+00	5.0000E+01		9.5000E-01	1.0000E-01
	(PSI)	1.0000E-01		1.0000E-01		5		3.0000E+00	6.0000E+00 3.5000E+00
33	CLOCK TIME	5.0000E+00	533						
	(OCTAL)	1.0000E+02							
34	AIRSPEED	2.0620E+02	534	.0000E+00					
	(KN)	7.5000E+00		1.0000E+02					
35	QNH	1.0230E+03	535						
	(MB)	.0000E+00							
36	S L TEMP	1.5000E+01	536						
	(DEG C)	.0000E+00							
37	ALTITUDE	.0000E+00	291	.0000E+00					
	(FT)	2.7000E+02		4.0000E+03					

38	T.A.S.	.0000E+00	538	.0000E+00
	(KN)	.0000E+00		1.0000E+02
39	WIND VEL	.0000E+00	539	.0000E+00
	(KN)	.0000E+00		4.0000E+01
40	WIND DIRN	.0000E+00	540	-1.8000E+02
	(DEG)	.0000E+00		1.8000E+02
41	B1S	.0000E+00	292	-1.0000E+01
	(DEG)	.0000E+00		1.0000E+01
42	A1S	.0000E+00	293	-1.0000E+01
	(DEG)	.0000E+00		1.0000E+01
43	THETA C	.0000E+00	294	1.0000E+01
	(DEG)	.0000E+00		2.0000E+01
44	THETA T	.0000E+00	295	.0000E+00
	(DEG)	.0000E+00		2.0000E+01
45	THETA C 75	.0000E+00	296	.0000E+00
	(DEG)	.0000E+00		1.0000E+01
46	PSI	.0000E+00	284	-2.0000E+01
	(DEG)	.0000E+00		2.0000E+01
47	PHI	.0000E+00	283	-2.0000E+01
	(DEG)	.0000E+00		2.0000E+01
48	PSI DOT D	.0000E+00	548	-1.0000E+01
	(DEG/S)	.0000E+00		1.0000E+01
49	THE DOT D	.0000E+00	549	-1.0000E+01
	(DEG/S)	.0000E+00		1.0000E+01
50	PHI DOT D	.0000E+00	550	-2.0000E+01
	(DEG/S)	.0000E+00		2.0000E+01
51	P D	.0000E+00	280	-2.0000E+01
	(DEG/S)	.0000E+00		2.0000E+01
52	Q D	.0000E+00	279	-1.0000E+01
	(DEG/S)	.0000E+00		1.0000E+01
53	R D	.0000E+00	281	-1.0000E+01
	(DEG/S)	.0000E+00		1.0000E+01
54	A X	.0000E+00	41	-5.0000E+00
	(FT/S**2)	.0000E+00		5.0000E+00
55	A Y	.0000E+00	42	-5.0000E+00
	(FT/S**2)	.0000E+00		5.0000E+00
56	A Z	.0000E+00	43	-1.0000E+01
	(FT/S**2)	.0000E+00		1.0000E+01
57	U DOT	.0000E+00	35	-5.0000E+00
	(FT/S**2)	.0000E+00		5.0000E+00
58	V DOT	.0000E+00	36	-5.0000E+00
	(FT/S**2)	.0000E+00		5.0000E+00
59	W DOT	.0000E+00	37	-1.0000E+01
	(FT/S**2)	.0000E+00		1.0000E+01
60	U DSH I	.0000E+00	560	.0000E+00
	(KN)	.0000E+00		1.0000E+02
61	V DSH I	.0000E+00	561	-2.0000E+01
	(KN)	.0000E+00		2.0000E+01
62	W DSH I	.0000E+00	462	-1.0000E+01
	(KN)	.0000E+00		1.0000E+02
63	HOR VEL I	.0000E+00	563	.0000E+00
	(KN)	.0000E+00		1.0000E+01
64	H I	.0000E+00	564	.0000E+00
	(FT)	.0000E+00		4.0000E+03
65	PSI DOT	.0000E+00	565	-1.0000E+01
	(DEG/S)	.0000E+00		1.0000E+01
66	THE DOT	.0000E+00	566	-1.0000E+01
	(DEG/S)	.0000E+00		1.0000E+01
67	PHI DOT	.0000E+00	567	-2.0000E+01
	(DEG/S)	.0000E+00		2.0000E+01
68	PSI I	.0000E+00	284	-2.0000E+01
	(DEG)	.0000E+00		2.0000E+01
69	THE I	.0000E+00	282	-2.0000E+01
	(DEG)	.0000E+00		2.0000E+01
70	PHI I	.0000E+00	283	-2.0000E+01
	(DEG)	.0000E+00		2.0000E+01

EXCEPTIONS

Channel No.	Flight No.	Cal Factor	Offset
15	1	-1.2200E-02	2.5400E+01
18	1	8.8400E-02	-1.7500E+02
26	1	-8.9800E-04	1.5530E+01
31	1	-1.3890E-04	5.1000E-01
32	1	-4.8800E-05	1.0000E-01
35	1	1.0150E+03	.0000E+00
37	1	.0000E+00	-1.6000E+02
18	2	8.8400E-02	-1.3600E+02
26	2	-9.0800E-04	1.5670E+01
31	2	.0000E+00	.0000E+00
32	2	.0000E+00	.0000E+00
35	2	1.0050E+03	.0000E+00
36	2	1.4000E+01	.0000E+00
37	2	.0000E+00	7.0000E+01
8	3	-1.5000E-02	3.2800E+01
11	3	-3.0300E-02	6.1240E+01
18	3	8.8400E-02	-1.3000E+02
31	3	.0000E+00	.0000E+00
32	3	.0000E+00	.0000E+00
35	3	1.0270E+03	.0000E+00
36	3	1.0000E+01	.0000E+00
37	3	.0000E+00	2.3000E+02
11	4	-3.0300E-02	6.1370E+01
18	4	8.8400E-02	-2.0800E+02
31	4	.0000E+00	.0000E+00
32	4	.0000E+00	.0000E+00
35	4	1.0250E+03	.0000E+00
37	4	.0000E+00	1.9000E+02
18	6	8.8400E-02	-6.7000E+01
31	6	.0000E+00	.0000E+00
32	6	.0000E+00	.0000E+00
35	6	1.0200E+03	.0000E+00
36	6	1.9000E+01	.0000E+00
37	6	.0000E+00	.0000E+00
9	7	-4.4700E-02	8.8300E+01
11	7	-3.0300E-02	6.1080E+01
18	7	8.8400E-02	-8.3000E+01
31	7	.0000E+00	.0000E+00
32	7	.0000E+00	.0000E+00
35	7	1.0200E+03	.0000E+00
36	7	1.3000E+01	.0000E+00
37	7	.0000E+00	1.6000E+02

15018 - Hover - Pedal Pulse Port - ASE on - Flt 4

RECORDED ON 09-Jan-87 AT 14:56:57 INTEGN INT = .0000E+00

RUN CPU TIME = 24.98 SEC.

BLK NUMBER =	276	277	72	278	527	292	293	295	294
Time (s)	PITCH STK (DEG)	ROLL STK (DEG)	YAW PEDAL (FT)	COLL STK (DEG)	YAW PPR (FT)	B1S (DEG)	A1S (DEG)	THETA T (DEG)	THETA C (DEG)
.0000E+00	-5.4896E-01	-4.2997E+00	3.8374E-02	1.1790E+01	9.3997E-03	1.0464E+00	-2.5963E+00	1.4155E+01	1.6338E+01
1.6667E-02	-5.3827E-01	-4.2997E+00	3.8192E-02	1.1790E+01	9.3630E-03	1.0462E+00	-2.5962E+00	1.4143E+01	1.6337E+01
3.3333E-02	-5.3827E-01	-4.3104E+00	3.8203E-02	1.1790E+01	9.3140E-03	1.0462E+00	-2.5955E+00	1.4135E+01	1.6337E+01
5.0000E-02	-5.4896E-01	-4.3211E+00	3.8374E-02	1.1790E+01	9.2650E-03	1.0461E+00	-2.5949E+00	1.4121E+01	1.6337E+01
6.6667E-02	-5.3827E-01	-4.3425E+00	3.8465E-02	1.1790E+01	9.2160E-03	1.0441E+00	-2.5943E+00	1.4110E+01	1.6336E+01
8.3333E-02	-5.2758E-01	-4.3425E+00	3.8556E-02	1.1790E+01	9.1670E-03	1.0433E+00	-2.5938E+00	1.4099E+01	1.6336E+01
1.0000E-01	-5.2758E-01	-4.3745E+00	3.8556E-02	1.1790E+01	9.1303E-03	1.0417E+00	-2.5927E+00	1.4090E+01	1.6335E+01
1.1667E-01	-5.2758E-01	-4.3959E+00	3.8556E-02	1.1790E+01	9.0935E-03	1.0405E+00	-2.5918E+00	1.4086E+01	1.6336E+01
1.3333E-01	-5.2758E-01	-4.4173E+00	3.8556E-02	1.1790E+01	9.0568E-03	1.0383E+00	-2.5910E+00	1.4074E+01	1.6335E+01
1.5000E-01	-5.4896E-01	-4.4280E+00	3.8556E-02	1.1790E+01	9.0200E-03	1.0355E+00	-2.5903E+00	1.4066E+01	1.6335E+01
1.6667E-01	-5.4896E-01	-4.4280E+00	3.8556E-02	1.1790E+01	9.0322E-03	1.0302E+00	-2.5897E+00	1.4072E+01	1.6335E+01
1.8333E-01	-5.5965E-01	-4.4280E+00	3.8556E-02	1.1790E+01	9.0445E-03	1.0244E+00	-2.5899E+00	1.4071E+01	1.6335E+01
2.0000E-01	-5.5965E-01	-4.4173E+00	3.8556E-02	1.1790E+01	9.0567E-03	1.0168E+00	-2.5894E+00	1.4078E+01	1.6335E+01
2.1667E-01	-5.4896E-01	-4.3959E+00	3.8556E-02	1.1790E+01	9.0690E-03	1.0076E+00	-2.5890E+00	1.4080E+01	1.6336E+01
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4.0000E-01	-5.5965E-01	-4.3638E+00	3.8737E-02	1.1790E+01	8.7750E-03	8.9088E-01	-2.5847E+00	1.4011E+01	1.6334E+01
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4.5000E-01	-5.5965E-01	-4.3638E+00	3.8556E-02	1.1790E+01	8.7505E-03	8.8223E-01	-2.5816E+00	1.4005E+01	1.6334E+01
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5.3333E-01	-5.5965E-01	-4.3318E+00	3.9101E-02	1.1790E+01	8.7260E-03	8.7855E-01	-2.5808E+00	1.4000E+01	1.6333E+01
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6.1667E-01	-5.7034E-01	-4.3425E+00	4.1102E-02	1.1790E+01	8.7260E-03	8.7859E-01	-2.5841E+00	1.4000E+01	1.6334E+01
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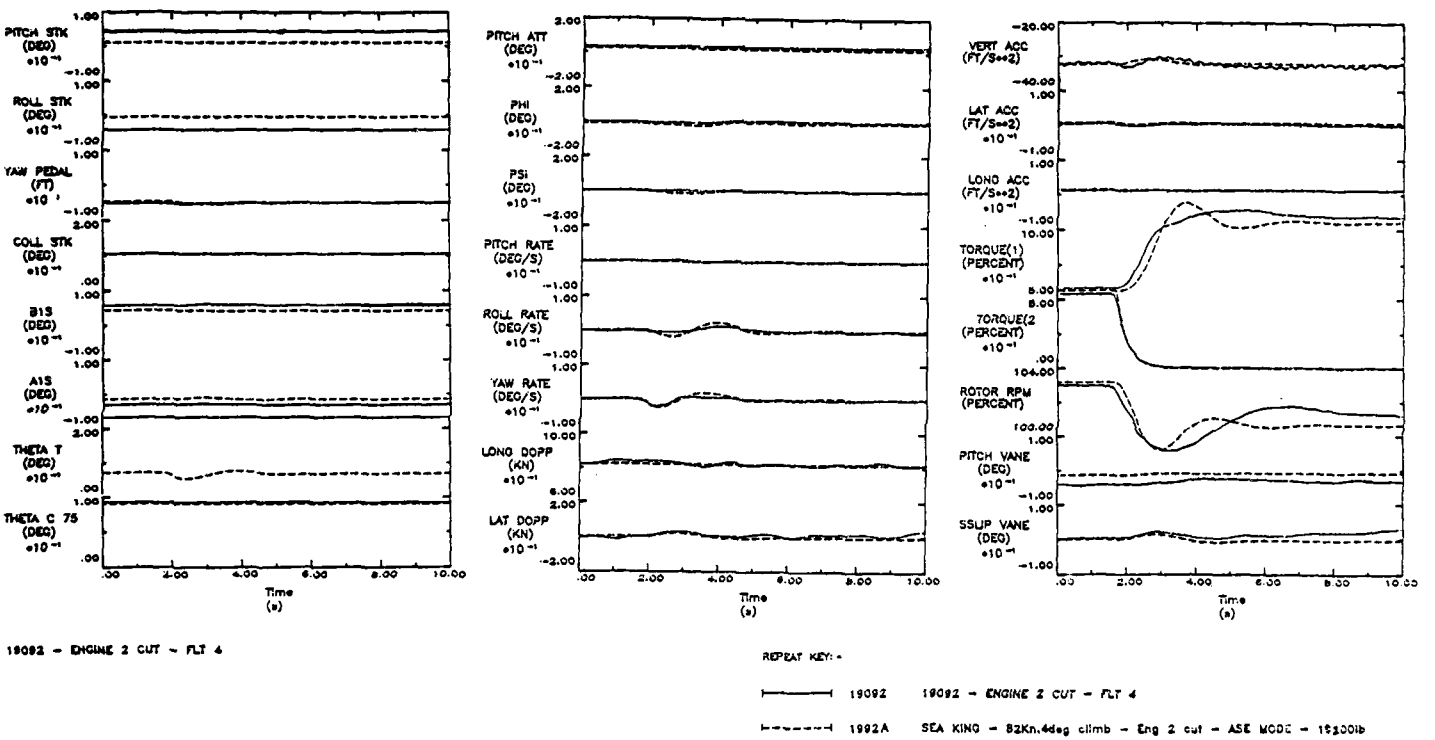
8.3333E-01	-6.5586E-01	-4.2462E+00	8.8214E-02	1.1795E+01	1.9702E-02	8.9752E-01	-2.6002E+00	1.6451E+01	1.6331E+01

APPENDIX C
First Page of Data File 15018.COL



APPENDIX D - Simulated Failure of One Engine

APPENDIX E
Model Modifications for Single Engine Cut

A description of the standard engine model as simulated in CSMP-10(ARL) is given in Fig. 7 of Ref. 6. The changes to this model (via CONfiguration, PARameter, and FUNction commands) are shown in Figure E.1 of this appendix.

In order to model the response of a single engine, the model is modified so that the response of the cut engine (Engine 2) is fed in as a *FUNction block, with a first order lag* simulating the torque decay.

Referring to Figure E.1, the detailed changes are as follows:

Blk	
302	Gain of 250 is halved to 125
313	Initial condition halved; time constant unchanged from standard value
314	Initial condition halved; time constant unchanged from standard value
325	Initial condition is half of total engine torque (lb ft); time constant = 0.3 s (found from inspection of flight data)
327	Gain of 3.18×10^{-3} to convert torque (lb ft) to %[1] (see below)
328	Gain of 3.18×10^{-3} to convert torque (lb ft) to % (see below)

Calculation of Gains for Blks 327, 328:

From Ref. 20,

$$111\% \text{ torque} \equiv 2778 \text{ SHP at } 103\% \text{ Nr}$$

and $$100\% \text{ Nr} \equiv 203 \text{ rpm}$$

$$\therefore \quad 103\% \text{ Nr} \equiv 1.03 \times 203 \approx 209 \text{ rpm} = 21.89 \text{ rad/s}$$

$$\Rightarrow 111\% \text{ torque} = \left(\frac{2778 \times 550}{21.89} \right) \approx 69810 \text{ lb ft for two engines}$$

Hence, for one engine,

$$\text{Gain} = \left(\frac{111}{0.5 \times 69810} \right) = 3.18 \times 10^{-3}$$

[1] % is unit displayed on cockpit gauge and is based on a nominal value (used for torque and rotor revs, Nr).

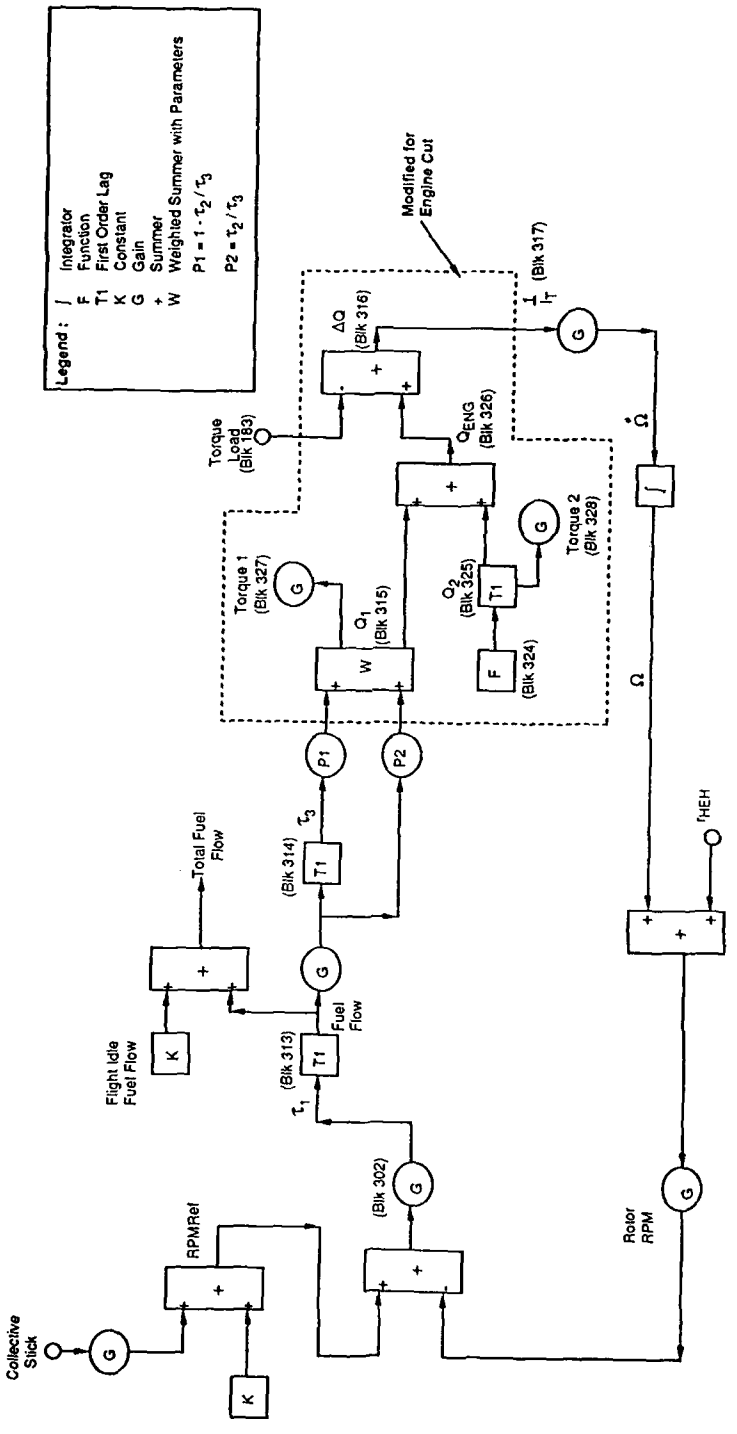


Figure E.1 Engine Cut Model as Simulated in CSMP-10

APPENDIX F
Files Required to Run TRANS

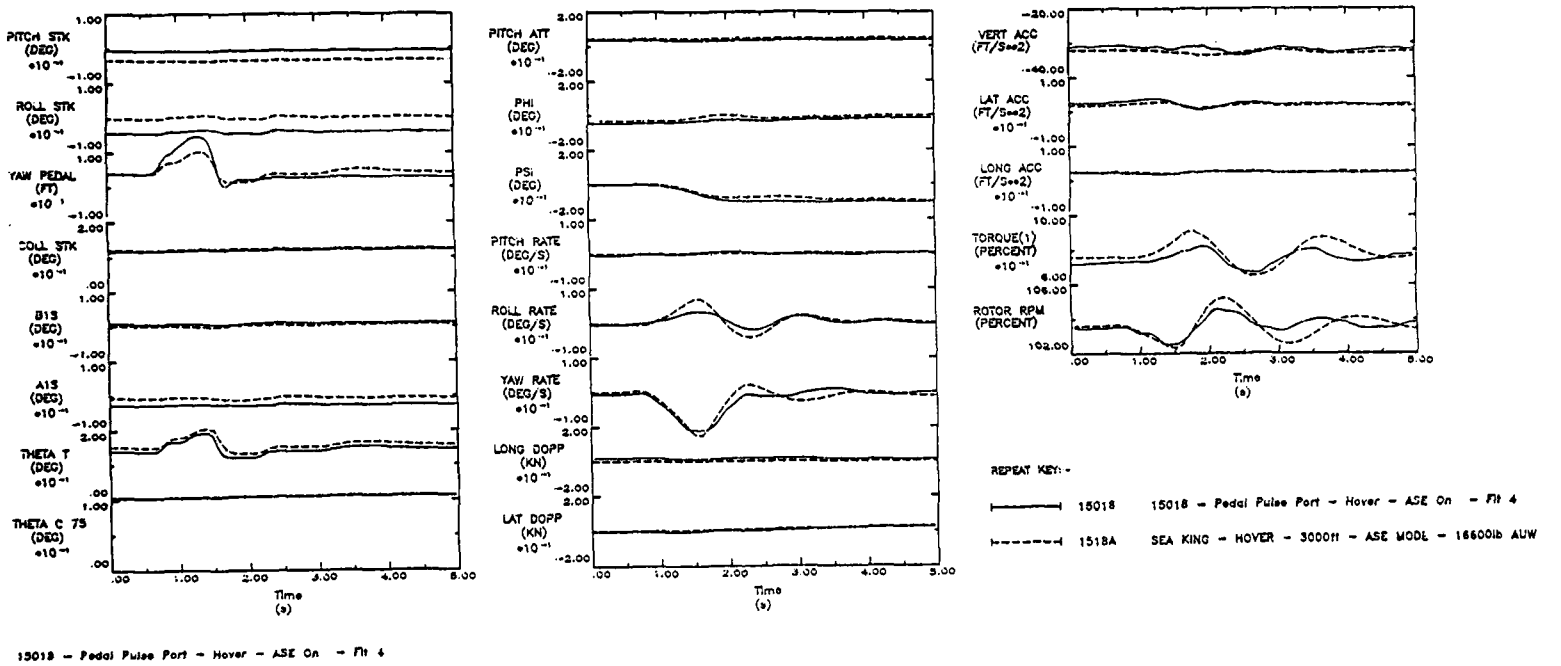
a) Scale File HOVER.SCA

Blk No.	Lower Limit	Upper Limit
-1	0.0000E+00	5.0000E+00
276	-1.0000E+01	1.0000E+01
277	-1.0000E+01	1.0000E+01
72	-1.0000E-01	1.0000E-01
278	0.0000E+00	2.0000E+01
292	-1.0000E+01	1.0000E+01
293	-1.0000E+01	1.0000E+01
295	0.0000E+00	2.0000E+01
296	0.0000E+00	1.0000E+01
282	-2.0000E+01	2.0000E+01
283	-2.0000E+01	2.0000E+01
284	-2.0000E+01	2.0000E+01
279	-1.0000E+01	1.0000E+01
280	-1.0000E+01	1.0000E+01
281	-1.0000E+01	1.0000E+01
287	-2.0000E+01	2.0000E+01
288	-2.0000E+01	2.0000E+01
16	-4.0000E+01	-2.0000E+01
17	-1.0000E+01	1.0000E+01
18	-1.0000E+01	1.0000E+01
212	6.0000E+01	1.0000E+02
290	1.0200E+02	1.0600E+02

Note: Headings shown are not stored in file.
Blk no. -1 represents time.

b) Block List File TRANS.BLK

```
L1
 276   277    72   278   292   293   295   296
L2
 282   283   284   279   280   281   287   288
L3
  16    17    18   212    29
```



15018 - Pedal Pulse Port - Hover - ASE On - Fit 4

APPENDIX G - TRANS Output (Dynamic Response - Pedal Input)

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0074C

16. ABSTRACT A mathematical model of the Sea King Mk 50 helicopter, as used in the Anti-Submarine Warfare (ASW) role, has been developed at ARL to run on the ELXSI 6400 computer. To validate this model, extensive flight trials have been conducted by the RAN. This document provides a catalogue of the many flight trials data files, shows how to access and process the flight data, and then how to run the mathematical model with inputs obtained from the flight data.

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